A Dissertation on

FETAL NUCHAL TRANSLUCENCY BY ULTRA SOUND - A SCREENING TOOL FOR FETAL ABNORMALITIES

Dissertation submitted to

THE TAMIL NADU Dr. M. G. R. MEDICAL UNIVERSITY

CHENNAI.

with partial fulfillment of the regulations

for the Award of the degree of

M.D., (Obstetrics & Gynaecology)

Branch – II

STANLEY MEDICAL COLLEGE

CHENNAI - 600 001.

APRIL 2012

BONAFIDE CERTIFICATE

Certified that this dissertation is the bonafide work of Dr. M.MEENA on **"FETAL NUCHAL TRANSLUCENCY BY ULTRASOUND - A SCREENING TOOL FOR FETAL ABNORMALITIES"** during her M.D., (Obstetrics & Gynaecology) course from April 2010 to April 2012 at the Stanley Medical College and Raja Sir Ramasamy Mudaliar Lying-in Hospital, Chennai.

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DECLARATION

I solemnly declare that the dissertation titled "**FETAL NUCHAL TRANSLUCENCY BY ULTRASOUND - A SCREENING TOOL FOR FETAL ABNORMALITIES"** is done by me at RSRM Lying in Hospital, Stanley Medical College and Hospital, Chennai during November 2010 to October 2011 under the guidance and supervision of **Prof. Dr.P. Vasanthamani, M.D., D.G.O.,** Professor and Chief of the Department of Obstetrics and Gynaecology, Stanley Medical College & RSRM Lying in Hospital, Chennai-13.

This dissertation is submitted to the Tamilnadu Dr. M.G.R Medical University towards the partial fulfillment of requirements for the award of M.D. Degree (Branch II) in Obstetrics and Gynaecology.

Place : Chennai

Date : 21-12-2011

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ACKNOWLEDGEMENT

At the outset, I would like to place on record my deep sense of gratitude to the Dean, Stanley Medical College, Chennai **Prof. Dr. S. Geetha Laksmi, M.D., Ph.D,** for her kind permission to use the hospital resources for this study.

I would like to express my sincere gratitude to my beloved Professor and Head of the Department of Obstetrics and *Gynaecology* **Prof.Dr.N.Hephzibah kirubamani, M.D., D.GO., MICOG., Ph.D**, RSRM Lying-in Hospital, for allowing me to undertake this study on "**FETAL NUCHAL TRANSLUCENCY BY ULTRASOUND - A SCREENING TOOL FOR FETAL ABNORMALITIES"** with much avidity.

In keeping with the maxim, "All is well that ends well", I was able to carry out my study to my fullest satisfaction, thanks to guidance, encouragement, motivation and constant supervision extended to me, by my beloved Chief *Prof.* **Dr.P.Vasanthamani M.D., D.G.O.,** Professor and Chief of Unit I. Hence my profuse thanks are due for her.

I would like to place my sincere thanks to **Prof.Dr.K.Ruckmani M.D., D.G.O.,** and all the Unit chiefs for their moral support.

I would be failing in my duty if I don't place on record my sincere thanks to those patients who were the subjects of my study.

I am bound by ties of gratitude to my respected Assistant Professors **Dr.S.Lavanya, Dr.J.Arumaikannu, Dr.A.Shanthi**, and all the Assistant Professors in general, for placing, guiding and goading me

on the right track from the very beginning of my career in Obstetrics and Gynaecology and till this day.

I am fortunate to have my colleague postgraduates of RSRM Lying in hospital for their invaluable suggestions, relentless help for shouldering my responsibilities. Simply words cannot express its depth for their unseen contributions.

I am also thankful to my parents, sister and lastly, my lovable thanks to my husband and my sons and all the family members for their moral support.

I thank the Almighty for his immense blessings and support throughout my life.

CONTENTS

ABBREVIATIONS

ASD	**-**	**Atrial septal defect**
β –HCG	**-**	**β Human chorionic gonadotrophin**
CHD	**-**	**Congenital heart disease**
CVS	**-**	**Chorionic villous sampling**
GDM	**-**	**Gestational Diabetes Mellitus**
LSCS	**-**	**Lower segment caesarean section**
MA	**-**	**Maternal age**
MAS	**-**	**Meconium Aspiration Syndrome**
MSAFP	**-**	**Maternal serum α fetoprotein**
NB	**-**	**Nasal bone**
NT	**-**	**Nuchal translucency**
PAPP-A	**-**	**Pregnancy associated plasma protein-A**
PROM	**-**	**Premature rupture of membranes**
VSD	**-**	**Ventricular septal defect**

Introduction

INTRODUCTION

Prenatal diagnosis of fetal structural malformations during either the first or the second trimester has helped to reduce perinatal morbidity and mortality and also helped in early termination of an anomalous fetus. Although many major fetal defects are diagnosable in the first trimester, the diagnostic accuracy is significantly higher in the mid-second trimester owing to the larger size and more advanced development of the fetus.

Mid second trimester screening method is not an ideal tool and search is on for early markers. A great deal of interest has been directed towards shifting prenatal screening for chromosomal abnormalities and fetal structural abnormalities to the first trimester (11-14 weeks of gestation) using the sonographic measurement of the fetal Nuchal Translucency (NT) alone or in combination with serum markers [Pregnancy associated plasma protein A (PAPP-A) + free β human chorionic gonadotrophin (β-HCG)][1,9].

History of NT measurement

Sonographic screening of aneuploidy became a reality in 1985 when Beryl Benacerraf demonstrated thickened nuchal fold in a Downs syndrome fetus[2].

Dr. Langdon Down (it is after his name that Downs syndrome has been named) 100 years back, reported that skin of affected fetus at the

back of the neck was too large and swollen. This excess skin thickness can be easily studied by ultrasound as Nuchal Translucency (at 11-14 weeks of gestation)[3].

Fetal Nuchal translucency thickness at 11-14 weeks scan has been combined with maternal age to provide an effective method of assessing the risk for chromosomal anomalies. In addition increased nuchal translucency identifies a higher proportion of major cardiac defects, skeletal defects and a wide range of genetic syndromes[4]. For example, Nicolaides (2004) reported approximately 90% sensitivity for trisomies 18 and 13 with a 1% false positive rate[5]. There is also strong association between increasing nuchal translucency and fetal cardiac anomalies. (Atzei and colleagues 2005; Simpson and colleagues 2007)[6,7]. Moreover, results may be abnormal in the setting of a number of structural fetal anomalies (Souka and colleagues 2001)[8].

It is widely accepted that the measurement of NT to screen fetal abnormalities should be combined with a search for detectable malformations. The American college of Obstetricians and Gynecologists (2007b) recommends that when the nuchal translucency measurement is 3.5 mm or greater with a normal fetal karyotype, then targeted sonographic examination, fetal echocardiography, or both should be considered[9].

Visualization of normal fetal anatomy in the first trimester provides reassurance to the patient and reduces anxiety. Early detection of fetal structural malformations allows timely referral to a tertiary centre.

For an invasive testing rate of 5% about 75% of trisomic pregnancies can be identified. Assessment of risk for chromosomal defects in the first trimester rather than the second trimester provides the option for earlier invasive diagnostic testing and consequently results in fewer traumas for those couples choosing termination of an affected pregnancy.

NT as a screening tool for fetal aneuploidy are less sensitive in younger women because of lower prevalence rates. Gestational age also affects the accuracy of Downs syndrome detection. Testing sensitivity is approximately 5 percent lower if performed at 13 weeks instead of 11 weeks[10].

A study group of the Royal College of Obstetricians and Gynaecologists has recommended that there is now sufficient evidence to support routine first-trimester nuchal translucency screening with appropriately trained sonographers using high resolution equipments, provided that the results should be subjected to an external agency for regular audit[11].

Aims & Objectives

AIMS AND OBJECTIVES

1. To assess fetal Nuchal translucency (NT) in an unselected population of pregnant women with viable singleton pregnancies.

2. To assess usefulness of increased NT in identifying abnormal fetuses.

Review of Literature

REVIEW OF LITERATURE

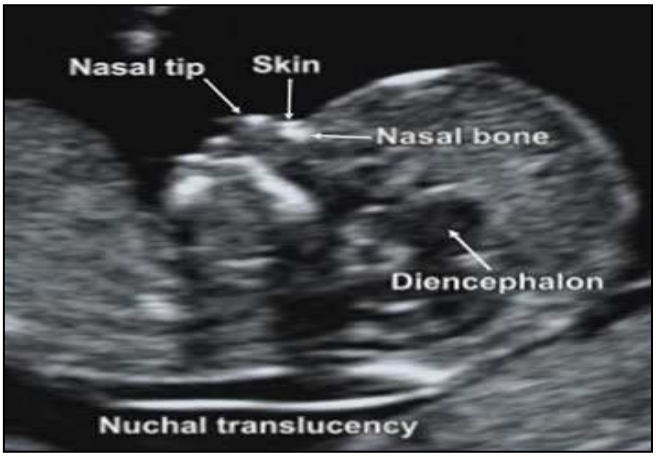
NUCHAL TRANSLUCENCY

1. DEFINITION

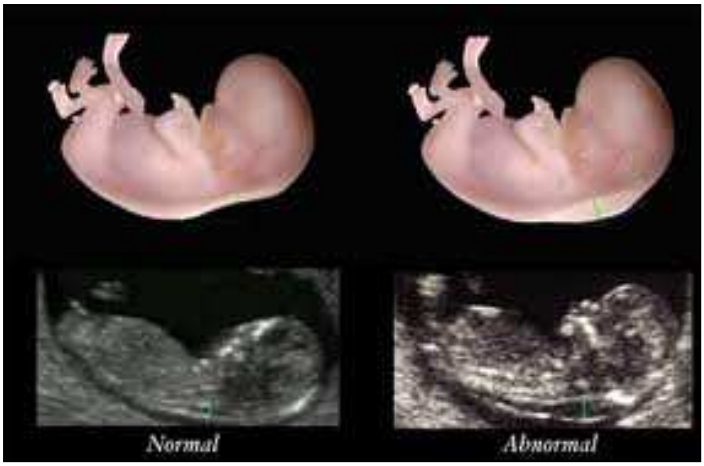
The Nuchal translucency is defined as the maximum thickness of the subcutaneous translucency between the skin and soft tissues overlying the cervical spine of the fetus and is typically observed in the first trimester (11 to 14 weeks) [4]

ULTRA SOUND PICTURES OF FETAL NUCHAL TRANSLUCENCY

First trimester Fetus



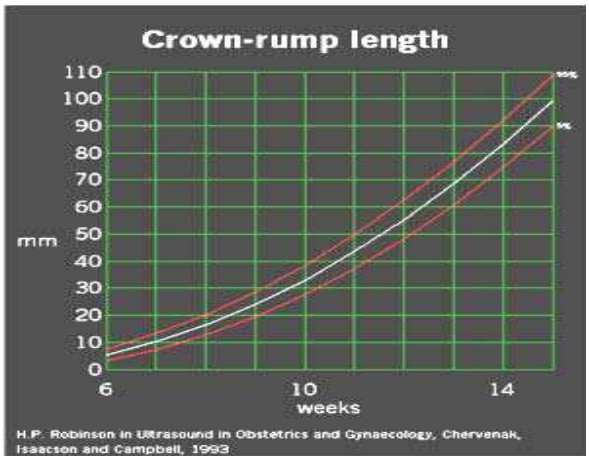
Midsagittal view for measuring NT by ultrasound



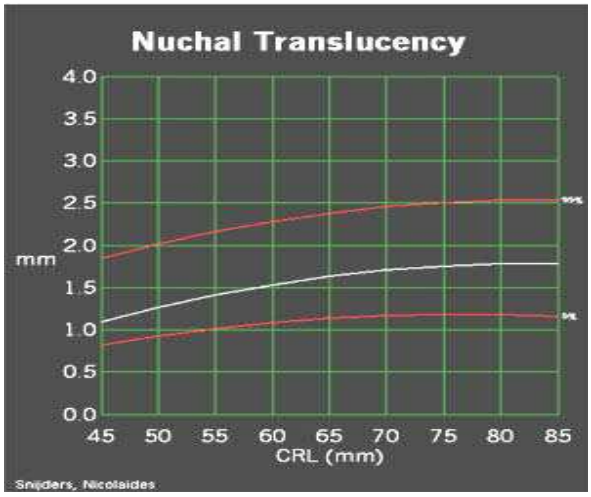
Normal NT **Abnormal NT**

2. NORMAL NT MEASUREMENTS

Fetal nuchal translucency thickness increases with crown – rump length (CRL) and, therefore, it is essential to take gestation into account when determining whether a given translucency thickness is increased[12-14].



CRL vs Gestational age (weeks)

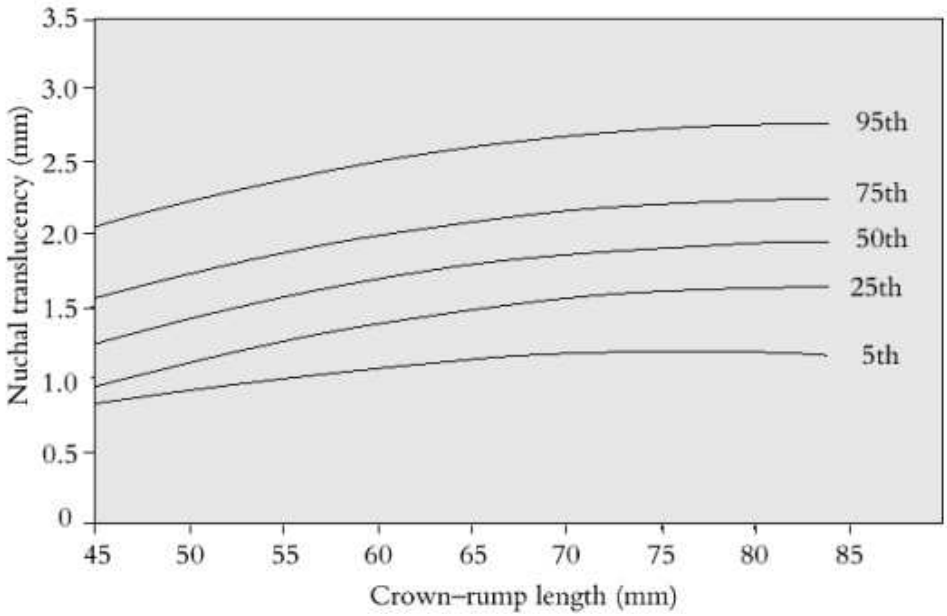


Nuchal Translucency normally increases with gestation (CRL)

The 50th percentile values for NT thickness are 1.2 mm and 1.9 mm for a CRL of 45mm (11th week) and 85 mm (13 weeks+6 days) respectively, and the 95th percentile values are 2 mm and 2.8 mm respectively.[15]

Currently the more accepted method is to base the cut off on a progressive rise, using the 95th percentile as the threshold for an abnormal measurement resulting in a more sensitive and specific indicator for the detection of an anomalous fetus.

Centile chart for NT



3. RISK FOR TRISOMY BASED ON NT

Less than 2.5 mm: risk is 5 times lesser for that age

More than 2.5 mm: 12 fold increased risk.[16]

Relative risk for having trisomy for different NT measurement

NT measurement (in mm)	Relative risk
3	3
4	18
5	28
>5.5	36

Increased nuchal translucency at 11 to 14 weeks is a common phenotypic expression of Trisomies, Turners syndrome and Triploidy. Increased NT, seen in either chromosomally abnormal or normal fetuses usually resolves during the second trimester, and rarely evolves as nuchal edema or severe hydrops.

Major chromosomal abnormalities are often associated with multiple fetal defects that can be detected by ultrasound examination.

“Soft signs” or Second Trimester ultrasound markers of Trisomy 21 are:-

- nuchal fold thickening
- nasal bone absence or hypoplasia
- brachycephaly (shortened frontal lobe)
- short ear length
- mild ventriculomegaly
- atrioventricular septal defects
- echogenic intracardiac focus
- duodenal atresia
- echogenic bowel
- mild hydronephrosis (pyelectasis)
- shortening of the limbs (femur & humerus)
- sandal gap (widened gap between first and second toes)
- clinodactyly (mid-phalanx hypoplasia of the fifth digit)
- widened iliac angle
- single transverse palmar crease.[16,17]

Trisomy 18 is associated with:-

- strawberry-shaped head
- choroid plexus cysts
- absent corpus callosum
- enlarged cisterna magna
- facial cleft
- micrognathia
- nuchal edema
- heart defects
- diaphragmatic hernia
- esophageal atresia
- exomphalos
- renal defects
- myelomeningocele
- growth restriction
- shortening of the limbs
- radial aplasia
- overlapping fingers
- talipes or rocker bottom feet. [16]

The overall risk for chromosomal abnormalities increase with the total number of defects that are identified. It is, therefore, recommended that, when a defect or a marker is detected at routine ultrasound examination, a thorough check is made for the other features of the

chromosomal abnormality known to be associated with that marker; if additional defects be identified, the risk is dramatically increased. In the case of apparently isolated defects, the decision of whether to carry out an invasive test depends on the type of defect.[16]

4. PATHOPHYSIOLOGY

The heterogeneity of conditions associated with increased NT suggests that there may not be a single underlying mechanism for the collection of fluid under the skin of the fetal neck[22]. Possible mechanisms include.

i) Cardiac dysfunction
ii) Venous congestion in the head and neck
iii) Altered composition of the extracellular matrix
iv) Failure of lymphatic drainage
v) Fetal anemia
vi) Fetal hypoproteinemia
vii) Fetal infection

i) Cardiac dysfunction

In chromosomally normal and abnormal fetuses with high nuchal translucency at 11 to 14 weeks, there is a high prevalence of abnormalities of the heart and major vessels.[16,17,18] Abnormal ductal flow (absent or reverse flow during atrial contraction) has been seen at 11 to 14 weeks in 90 percent of fetuses with cardiac anomalies.[16]

In trisomic fetuses with increased NT there are increased level of atrial and brain natriuretic peptide mRNA in fetal hearts, suggesting the presence of heart strain.[16]

Diameter of the aortic isthmus is narrower, whereas ascending aorta and aortic valve are wider than in normal fetuses. Widening of ascending aorta together with narrowing of the aortic isthmus could lead to over perfusion of the tissues of the head and neck and may be responsible for the increased NT in trisomic fetuses. With advancing gestation, there is differential growth in the diameter of the great vessels and the diameter of the aortic isthmus increases more rapidly than the diameters of the aortic valve and distal ductus. Therefore, with increasing gestation, the hemodynamic consequences of narrowing of the isthmus may be overcome and this could offer an explanation for the gestational age-related spontaneous resolution of NT. The same explanation is possibly applicable to abnormality in Ductus Venosus (DV) flow between 11 and 14 weeks, resulting in spontaneous resolution in aneuploidic fetuses.[16]

ii) Venous congestion in the head and neck

Venous congestion in the head and neck due to constriction of the fetal body in amnion rupture sequence or superior mediastinal compression found in diaphragmatic hernia or the narrow chest in skeletal dysplasia.[23]

iii) Altered composition of the extracellular matrix

Many of the component proteins of the extracellular matrix are encoded on chromosomes 21, 18 or 13. Alterations in collagen metabolism (such as achondrogenesis type II, Nance – Sweeney syndrome, osteogenesis imperfecta type II), abnormalities of fibroblast growth factor receptors (such as achondroplasia and thanatophoric dysplasia) or disturbed metabolism of peroxisome biogenesis factor (such as Zellweger syndrome) can also produce increase in nuchal translucency. Immuno histo chemical studies, examining the skin of chromosomally abnormal fetuses, have demonstrated specific alterations of the extra cellular matrix, which may be attributed to gene dosage effects (Von Kaisen Berg et al 1998).[24]

iv) Failure of lymphatic drainage

Abnormal or delayed development of fetal lymphatic system, dilatation of jugular lymphatic sacs, developmental delay in the connection with the venous system, or a primary abnormal dilatation or proliferation of the lymphatic channels interfering with a normal flow between the lymphatic and venous systems.[25] Immunohistochemical studies in nuchal skin tissue from fetuses with Turners syndrome have shown that the lymphatic vessels in the upper dermis are hypoplastic (Von Kaisenberg et al 1999).[26]

In chromosomally normal fetuses with increased NT, deficient lymphatic drainage, due to hypoplastic or aplastic lymphatic vessels, is

found in association with Noonan syndrome[27] and congenital lymphedema. Failure of lymphatic drainage due to impaired fetal movements in various neuromuscular disorders.[22]

v) Fetal anemia

Genetic causes of fetal anemia such as alpha Thalassemia, Diamond Blackfan anemia, Congenital erythropoietic porphyria, Dyserythropoietic anemia, Fanconi anemia and possibly congenital infection related anemia can present with increased fetal NT.[22,28]

vi) Fetal hypoproteinemia

Hypoproteinemia is implicated in the pathophysiology of both immune and non-immune hydrops fetalis (Nicolaides et al 1985). In the first trimester, hypoproteinemia due to proteinuria may be the underlying mechanism for the increased NT in fetuses with congenital nephrotic syndrome.[29]

vii) Fetal infection

The only infection that has been reported in association with increased NT is Parvovirus B_{19}. In this condition, the increased NT has been attributed to myocardial dysfunction or fetal anemia due to suppression of hemopoiesis.[30,31]

Transient nature of Nuchal translucency between 11-14 weeks[16]

There is a brief opportunity between 11-14 weeks of gestation when the fetal lymphatic system is developing and the peripheral resistance of the placenta is high. After 14 weeks the lymphatic system is

likely to have developed sufficiently to drain away any excess fluid and changes to the placental circulation. So, after this time any abnormalities causing fluid accumulation may seem to correct themselves and then go undetected by measuring NT.[16]

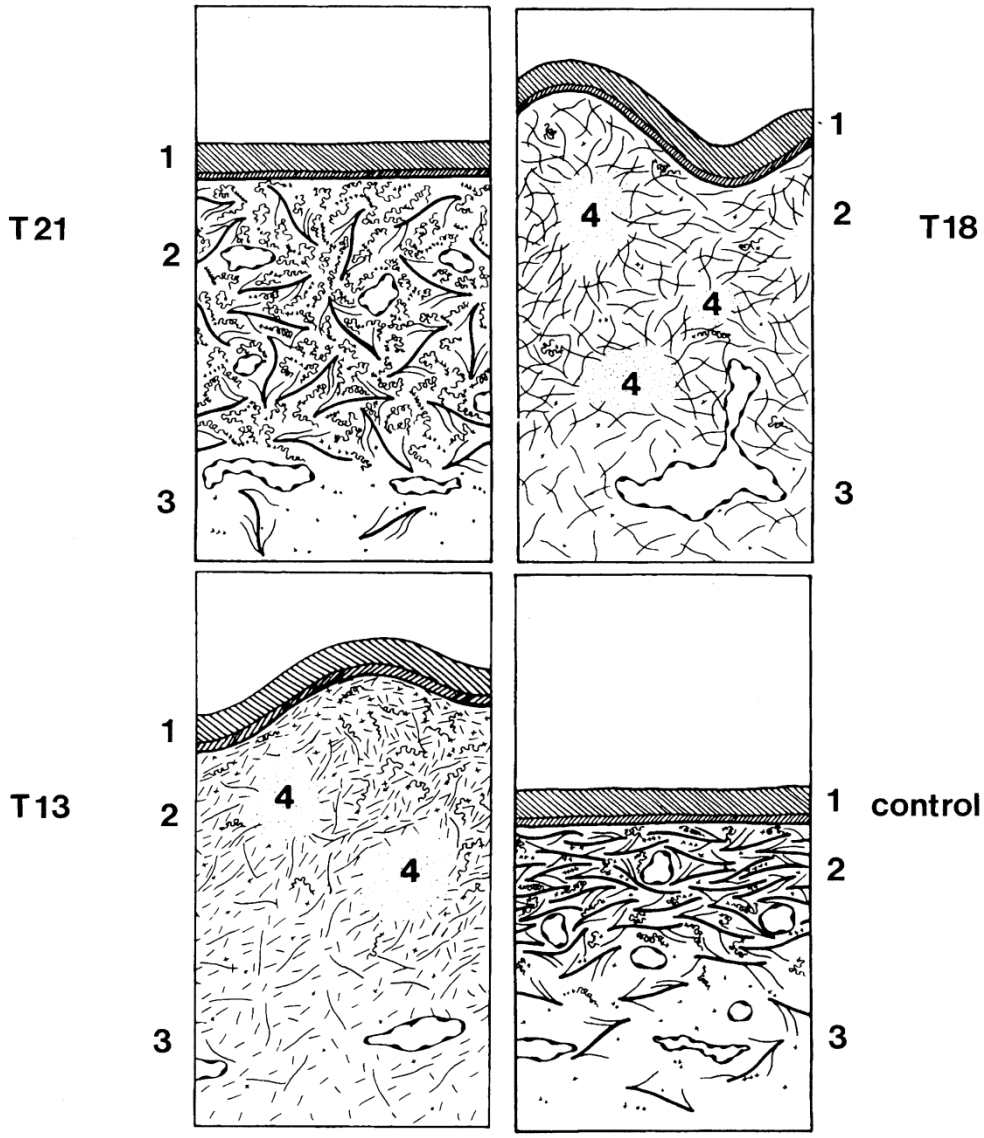
The reasons for selecting 14 weeks of gestation as the upper limit are:

1) To provide women who have affected fetuses the option of an earlier and safer form of termination.
2) The incidence of abnormal accumulation of nuchal fluid in chromosomally abnormal fetuses is lower at 14-18 weeks of gestation than at <14 weeks of gestation.[33,34,35]
3) The success rate for taking a measurement at 11-14 weeks of gestation is 98% to 100% which falls to 90% at more than 14 weeks of gestation because the fetus is often in a vertical position which makes it more difficult to obtain the appropriate image.[36,37]

The reason for selecting 11 weeks of gestation, as the earliest gestation was:

Screening necessitates the availability of diagnostic test, and in the early 1990s, it was appreciated that CVS before 10 weeks of gestation was associated with transverse limb reduction defects.

It was realized that many major fetal abnormalities could be diagnosed at NT scan, provided the minimum gestation was 11 weeks.[38,39,40,80]



Schematic drawing illustrating the main morphological characteristics of the nuchal skin of fetuses with trisomy 21 (top left), trisomy 18 (top right) and trisomy 13 (bottom left) and the nuchal skin of a normal control fetus (bottom right). In trisomy 21 there is a high number of collagen bundles in waveforms, irregularly arranged and densely packed; there are no cavities; the dermis is thickened; collagen type VI and glycosaminoglycans (hyaluronan) are abundant in the dermis; and collagen type Ifiber bundles are more widely spaced than in the normal control. In trisomy 18, the dermis contains fluid filled cavities and dilated vessels crossing from the subcutis to dermis; the collagen fibres are thinner and shorter, predominantly collagen type III. In trisomy 13, the collagen fibres alternate between loosely arranged areas with little precipitate and `patchy' more dense areas with intense staining and excess of collagen type III and VI. 1 epidermis, 2 dermis, 3 subcutis, 4 fluid-filled cavities; fibrillar bundles of collagen type I, collagen type III, collagen type VI, hyaluronan, blood and/or lymphatic vessels, free interstitial fluid[24].

5. MEASUREMENT OF NUCHAL TRANSLUCENCY

The average time allocated for each nuchal scan should be at least 10-20 minutes.

Measurement Criteria

In a recent review, Nicolaides et al described the measurement criteria necessary to achieve uniformity of the measurement.[42]

1) All sonographers performing fetal scans should be appropriately trained and their results subjected to rigorous audit. The fetal medicine foundation, under the auspices of the international society of ultrasound in obstetrics and Gynecology, has introduced a certificate of competence in the 11-14 weeks scan, which is awarded to those sonographers who can perform the scan to a high standard and can demonstrate a good knowledge of the diagnostic features and management of the conditions identified by this scan.
2) The ultrasound equipment must be of good quality, it should have a video-loop function and the calipers should be able to provide measurements to one decimal point.[15]
3) NT can be measured successfully by transabdominal ultrasound examination in about 95% of cases; in the others, it is necessary to perform transvaginal sonography.[41]
4) The ability to measure NT and obtain reproducible results improves with training; good results are achieved after 80 and 100 scans for the transabdominal and the transvaginal routes, respectively (Braithwaite et al., 1996)[41]. The intra-observer and

inter-observer differences in measurements are less than 0.5mm in 95% of cases (Pandya et al., 1995)[43].

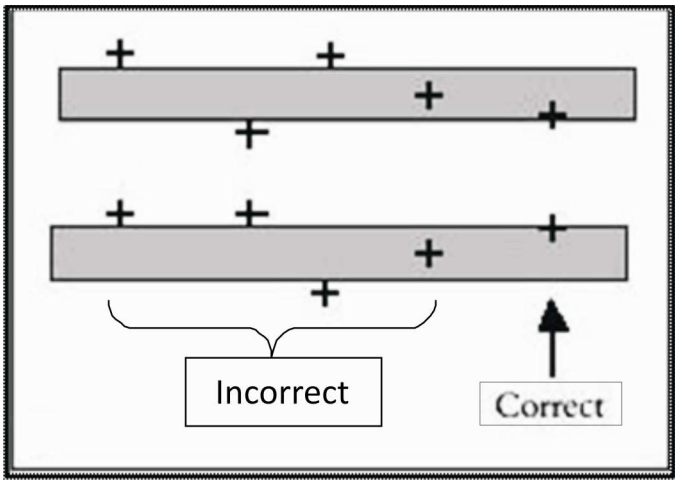
5) The minimum fetal CRL should be 45 mm and the maximum 84 mm. The optimal gestational age for measurement of fetal NT is 11 to 13 weeks+6 days.[36,44]

6) Fetal NT increases with CRL and therefore it is essential to take gestation into account when determining whether a given translucency thickness is increased (Snijders et al., 1998).

7) A good mid sagittal section of the fetus, as for measurement of fetal CRL, should be obtained and the NT should be measured with the fetus in the neutral position. When the fetal neck is hyperextended the measurement can increase by 0.6mm and when the neck is flexed, the measurement can decrease by 0.4mm (Whitlow et al., 1998). Only the fetal head & the upper thorax should be included in the image.[45]

8) The magnification should be such that each increment in the distance between calipers should be only 0.1mm.[45] Appropriate magnification is greater than 70% image.[15] A study, in which rat heart ventricles were measured initially by ultrasound and then by dissection, has demonstrated that ultrasound measurements can be accurate to the nearest 0.1-0.2mm (Braithwaite et al., 1996).

9) Calipers are placed at the inner borders of the NT space.[15]



Correct placement of calipers

10) Care must be taken to distinguish between fetal skin and amnion because, at this gestation, both structures appear as thin membranes (Nicolaides et al, 1992)[46]. This is achieved by waiting for spontaneous fetal movement away from the amniotic membrane; alternatively, the fetus is bounced off the amnion by asking the mother to cough and or tapping the maternal abdomen.

11) The maximum thickness of the subcutaneous translucency between the skin and the soft tissue overlying the cervical spine should be measured. During the scan, more than one measurement must be taken and the maximum one should be recorded.[22]

12) The umbilical cord may be around the fetal neck in 5-10% of cases and this finding may produce a falsely increased NT, adding about 0.8mm to the measurement (Schaefer et al., 1998).[47]

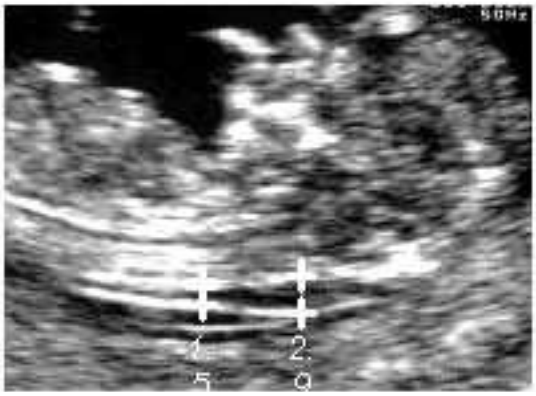
Ultrasound pictures of 12-weeks fetus.

This image is appropriate for measurement of the nuchal translucency (NT) because only the fetal head and upper thorax are included and the nuchal membrane, which is thin, can be seen separate from the amniotic membrane.

In this image the magnification is too small for accurate measurement of NT

The fetal neck is hyper extended

The fetal neck is too flexed



The maximum measurement of NT should be taken.

The umbilical cord is round the neck. In this case the NT should be measured both above and below the cord and the average of the two measurements should be used in the calculation of risk

In all six images there is a good sagittal section of the fetus.

In such cases, the measurements of NT above and below the cord are different and, in the calculation of risk, it is more appropriate to use the smaller measurement.[47]

Pitfalls in the measurement of NT[20,47]

- A loose amnion that can be mistaken for the nuchal skin edge.
- Nuchal cord.
- Encephalocele.
- An amniotic band.

How to avoid bias?

- To wait for spontaneous fetal activity as the fetus bounces from the amnion, these edges can be distinguished more reliably.[48]
- The Color Doppler can be helpful in evaluating the presence of an umbilical cord in the vicinity of the fetal neck.[48]
- To magnify the image so that care can be taken to distinguish the fetal skin from amnion.[45]

6. IMPLEMENTATION

NT – Calculation of patient-specific risk

- Every woman has a risk that her fetus has a chromosomal defect. In order to calculate the individual risk, it is necessary to take into account the background or a “priori risk”, which depends on the maternal age and gestation and multiply this by a series of factors

or likelihood ratios, which depends on the results of a series of screening tests carried out during the course of the pregnancy.[22]

- The likelihood ratio for a given sonographic or biochemical measurement is calculated by dividing the percentage of chromosomally abnormal fetuses by the percentage of normal fetuses with that measurement.

Prospective studies in more than 2,00,000 pregnancies, including more than 900 fetuses with Trisomy 21, have demonstrated that NT screening can identify more than 75% of fetuses with Trisomy 21, for a false positive rate of 5%.[22]

7. OUTCOME OF FETUSES WITH INCREASED NT

1) Chromosomal Defects[81-83]

The prevalence of chromosomal defects increases exponentially with NT thickness.[78,79] About 50% have Trisomy 21 (Downs syndrome) 25% have Trisomy 18 or 13, 10% have Turners syndrome, 5% have Triploidy and 10% have other chromosomal defects (Snijders et al 1998).[49]

2) Fetal Death

In chromosomally normal fetuses, the prevalence of fetal death increases exponentially with NT thickness from 1.3% in those with NT between the 95th and 99th percentiles to about 20% for NT of 6.5mm or more. The majority of fetuses that die do so by 20 weeks and they usually

show progression from increased NT to severe Hydrops (Souka et al 2001, Michailidis and Economides, 2001).[8,50]

3) Lethal fetal abnormalities

Major fetal abnormalities are defined as those requiring medical and or surgical treatment or conditions associated with mental handicap. The prevalence of major fetal abnormalities in chromosomally normal fetuses increase with NT thickness from 1.6% in those with NT below the 95th percentile to 2.5% for NT between the 95th and 99th percentiles and exponentially thereafter to about 45% for NT of 6.5 mm or more (Souka et al 2001, Michailidis and Economides, 2001).[8,50]

4) Developmental delay

Follow up of chromosomally and anatomically normal features with increased NT reported that the prevalence of developmental delay is 2-4% (Souka et al 2004).[51]

5) Chromosomally normal fetuses with increased NT

In chromosomally normal fetuses, survival decreases with nuchal thickness from 97 percent for 3 mm to 53 percent for 5 mm or more. In all babies that survived, the translucency resolved by 20 weeks. Incidence of structural defects is 4 percent for 1 mm. Persistence or increase and late development of nuchal edema are possible. Incidence of abortion is 2 percent for 3 mm, 4 percent for 4 mm and 13 percent for 5 mm or more.[52]

a. Cardiac Defects

There is a high association between increased NT and cardiac defects in both chromosomally abnormal and normal fetuses (Hyett et al 1997, 1999).[51] In chromosomally normal fetuses, the prevalence of major cardiac defects increases exponentially with NT thickness from 1.6/1000 in those with NT below the 95th percentile, to about 1% for NT of 2.5-3.4 mm, 3% for NT of 3.5-4.4mm, 7% for NT of 4.5-5.4mm, 20% for NT of 5.5-6.4 mm and 30% for NT of 6.5mm or more (souka et al 2004, Hyett et al 1997, 1999).[17,51]

Increased NT and cardiac disease: Specialist Echocardiography is indicated in all fetuses with increased nuchal translucency thickness because, in such fetuses, the incidence of major cardiac defects is substantially higher than in pregnancies with maternal diabetes, family history and exposure to drugs, where fetal Echocardiography is widely considered to be necessary.[53]

b. Pulmonary defects

- Diaphragmatic hernia
- Cystic adenomatoid malformation (Sebire et al 1997)[54]
- Fryn syndrome

c. Abdominal wall defects

- Cloacal exostrophy
- Exomphalos
- Gastroschisis (snijders et al 1995).[55]

d. Central nervous system defects

- Acrania / anencephaly
- Agenesis of the corpus callosum
- Craniosynostosis
- Dandy Walker malformation
- Diastometamyelia
- Encephalocele
- Fowler syndrome
- Holoprosencephaly
- Hydrolethalus syndrome
- Iniencephaly
- Joubert syndrome
- Macrocephaly
- Microcephaly
- Spina bifida
- Trigonocephaly C
- Ventriculomegaly

e. Gastrointestinal defects

- Crohn’s disease
- Duodenal atresia
- Esophageal atresia
- Small bowel obstruction

f. Fetal anemia

- Blackfan Diamond anaemia
- Congenital erythropoietic porphyria
- Dyserythropoietic anaemia

- Fanconi anemia
- Parvovirus B19 infection
- α-Thalassaemia

g. Genitourinary defects

- Ambiguous genitalia
- Congenital adrenal hyperplasia
- Congenital nephrotic syndrome
- Hydronephrosis
- Hypospadias
- Infantile polycystic kidnesy
- Meckel – Gruber syndrome
- Megacystis
- Multicystic dysplastic kidneys
- Renal agenesis

h. Neuromuscular defects

- Fetal akinesia deformation sequence
- Myotonic dystrophy
- Spinal muscular atrophy

i. Metabolic defects

- Beckwith – Wiedemann syndrome
- GM1 gangliosidosis
- Long-chain 3-hydroxyacyl-coenzyme A dehydrogenase deficiency
- Mucopolysaccharidosis type VII
- Smith-Lemli-Opitz syndrome
- Vitamin D resistant rickets

- Zellweger syndrome

j. Facial defects

- Agnathia/micrognathia
- Facial cleft
- Microphthalmia
- Treacher-Collins syndrome

k. Nuchal defects

- Cystic hygroma
- Neck lipoma

l. Skeletal defects

- Achondrogenesis
- Achondroplasia
- Asphyxiating thoracic dystrophy
- Blomstrand osteochondrodysplasia
- Campomelic dwarfism
- Cleidocranial dysplasia
- Hypochondroplasia
- Hypophosphatasia
- Jarcho-Levin syndrome
- Kyphoscoliosis
- Limb reduction defect
- Nance-Sweeney syndrome
- Osteogenesis imperfecta
- Roberts syndrome
- Robinow syndrome

- Short rib polydactyly syndrome
- Sirenomelia
- Talipes equinovarus
- Thanatophoric dwarfism
- VACTER association

m. Other defects

- Body stalk anomaly[49]
- Brachmann-de Lange syndrome
- CHARGE association
- Deficiency of the immune system
- Congenital lymphedema
- EEC syndrome
- Neonatal myoclonic encephalopathy
- Noonan syndrome
- Perlman syndrome
- Stickler syndrome
- Di George Syndrome
- Unspecified syndrome
- Severe developmental delay

GENETIC SYNDROMES

Genetic syndrome	Inheritance	Birth prevalence	Prognosis and common sonographically detectable abnormalities
Achondrogenesis	AR	1 in 40,000	Lethal skeletal dysplasia. Severe limb shortening, narrow thorax, hypomineraliztion of the vertebral bodies. Mineralization of the skull normal in type II and poor in type I.
Achondroplasia*	AD	1 in 26,000	Intelligence and life expectancy are normal. Macrocephaly, depressed nasal bridge, lumbar lordosis and short limbs, usually after 22 weeks.
Adrenal hyperplasia*	AR	1 in 5,000	Deficiency in one of the enzymes of cortisol biosynthesis, resulting in overproduction of cortisol precursors and androgens. Increased NT, ambiguous genitalia in females.
Asphyxiating thoracic dystrophy	AR	1 in 70,000	Variable prognosis from neonatal death to normal survival. Narrow chest and rhizomelic limb shortening, which may not become apparent until after 22 weeks.
Beckwith Wiedemann syndrome	Sporadic	1 in 14,000	In some cases, there is mental handicap, which is thought to be secondary to inadequately treated hypoglycemia. About 5% develop tumors during childhood, most commonly nephroblastoma and hepatoblastoma. Prenatal sonographic features include macrosomia and exomphalos.
Blackfan-diamond anemia	AD, AR	1 in 200,000	Congenital hypoplastic anemia requiring treatment with sterioids and repeated blood transufions. The risk of hematologic malignancies, mainly acture leukemia, is increased. Thumb defects, hypertelorism, cardiac and urogenital anomalies.
Blomstrand Osteochondrodysplasia	AR	Rare	Lethal skeletal dysplasia. Severe limb shortening, narrow thorax, increased bone density.
Brachmann-Cornelia de Lange syndrome	AD	1 in 160,000	Mental handicap. Fetal growth restriction, short limbs, heart defects, diaphragmatic hernia.
Campomelic dysplasia	AR	1 in 200,000	Lethal skeletal dysplasia. Short and bowed lower limbs with narrow thorax.
CHARGE association	Sporadic	Rare	Acronym for Coloboma of the eye, Heart anomaly, choanal Atresia, growth and mental retardation, Gonadal hypoplasia and Ear abnormalities and/or deafness. There may not be any antenatal sonographic findings.
Cleidocranial dysplasia	AD	Rare	Normal life expectancy. Hypoplastic

Genetic syndrome	Inheritance	Birth prevalence	Prognosis and common sonographically detectable abnormalities
			clavicles and nasal bone.
Di George syndrome	Sporadic	1 in 4,000	Results from de novo 22q 11 deletion in 90% of cases. Characterized by neonatal hypocalcemia, due to hypoplasia of the parathyroid glands, and susceptibility to infection due to hypoplasia or aplasia of the thymus gland. A variety of cardiac malformations are seen, including tetralogy of Fallot, interrupted aortic arch, truncus arteriosus, right aortic arch and aberrant right subclavian artery. Short stature and mild to moderate learning difficulties are common.
Dyserythropoietic	AD, AR	Rare	Congenital, usually mild anemia. In some cases there is severe anemia presenting with anemia fetal hydrops.
Ectrodactyly-ectodermal dysplasia-cleft palate syndrome	AD	Rare	Wide variability in phenotypic expression. Split hand and foot, cleft lip and/or palate.
Erythropoietic Porphyria (Gunther's disease)	AR	Rare	Usually presents during childhood with severe cutaneous photosensitivity with progressive bullous lesions, leading to infection, bone resorption, cutaneous deformity and chronic hemolytic anemia. Severe cases present with fetal hydrops.
Fanconi anemia	AR	1 in 22,000	Congenital aplastic anemia characterized by pancytopenia and spontaneous chromosome instability. The phenotype and age of onset are variable. There may be no prenatal sonographically detectable abnormalities.
Fetal akinesia deformation sequence	AR, Sporadic	Rare	Heterogenous group of conditions resulting in multiple joint contractures, frequently associated with fetal myopathy, neuropathy or an underlying connective tissue abnormality. Severe cases present with arthrogryposis and increased NT in the first trimester.
Fowler syndrome	AR	Rare	Proliferative vasculopathy of the central nervous system that leads to disruption, disorganization and hemorrhagic necrosis of the developing brain. Prenatal features include hydranencephaly and arthrogryposis.
Fryn syndrome	AR	1 in 15,000	Usually lethal. Diaphragmatic hernia, digital defects, short webbed neck
GM 1-Gangliosidosis*	AR	Rare	Progressive neurological deterioration, resulting in early and severe retardation of both motor and mental development. Death occurs within the first 10 years of

Genetic syndrome	Inheritance	Birth prevalence	Prognosis and common sonographically detectable abnormalities
			life from chest infections. Prenatal sonographic findings include visceromegaly and generalized edema.
Hydrolethalus syndrome	AR	1 in 20,000	Lethal condition characterized by hydrocephalus, absent corpus callosum, facial cleft, micrognathia, polydactyly, talipes and cardiac septal defects.
Hypochondroplasia	AD	1 in 26,000	Resembles achondroplasia and is characterized by short-limb dwardfism manifesting during childhood. Prenatally there may be short limbs and macrocephaly.
Hypophosphatasia	AR	1 in 100,000	Subdivided into perinatal,infantile,childhood and adult forms, according to the age of onset of symptoms. In the perinatal type there is hypomineralization of the skull and spine, short limbs and narrow thorax.
Infantile polycystic kidney disease	AR	1 in 10,000	Subdivided into perinatal, neonatal, infantile, and juvenile, depending on the severity of the disease and age of presentation. Prenatal sonographc features include large, echogenic kidneys and oligohydramnios.
Jarcho-levin syndrome	AR	1 in 500,000	Heterogeneous disorder characterized by scoliosis and disorganization of the spine. There are two types. In spondylothoracic dysplasia there is a narrow thorax and lethal respiratory insufficiency in infancy. Spondylocostal dysplasia is associated with survival to adult life but with some degree of physical disability.
Joubert syndrome	AR	Rare	Profound mental retardation and developmental delay. Death usually occurs in the first 5 years of life. Partial or complete absence of the cerebellar vermis.
Long-chain 3-hydroxyacyl-coenzyme A dehydrogenase deficiency*	AR	Rare	Lethal disorder. Muscular hypotonia, cardiomyopathy, hydrops.
Lymphedema	AD	Rare	Hypoplastic/aplastic lymphatic vessles, usually affecting the lower limbs. Three clinical subtypes, congenital (Milroy disease, present at birth), praecox (pubertal onset) and tarda (midlife onset), with congenital lymphoedema being the rarest and most severe of the three. There may be no prenatal sonographic findings.
Meckel-Gruber syndrome	AR	1 in 10,000	Lethal. Typical features are encephalocele, bilateral polycystic kidneys, polydactyly.

Genetic syndrome	Inheritance	Birth prevalence	Prognosis and common sonographically detectable abnormalities
Mucopolysaccharidosis type VII*	AR	Rare	Mental retardation, short stature, macrocephaly, hearing loss, corneal opacities and recurrent lower respiratory tract infection.
Myotonic dystrophy*	AD	1 in 25,000	The genetic defect is an amplified trinucleotide repeat in a protein kinase gene on chromosome 19. Age of onset and severity of disease vary with the number of repeats. The mutation can worsen progressively in successive generations and the severe congenital form occurs almost exclusively in the offspring of affected women. Prenatal sonographic signs may be decreased fetal movements and polyhydraminos in the third trimester.
Nance-Sweeney syndrome	AR	Rare	Intelligence and life expectancy are normal. Short limbs, vertebral abnormalities.
Nephritic syndrome*	AR in Finland	1 in 8,000	Renal failure requiring transplantation within the first 4 years of life. Prenatally may present with transient hydrops.
Noonan syndrome	AD	1 in 2,000	Life expectancy is probably normal in those without severe heart disease. Mild mental retardation is present in about one-third of cases. The majority of cases are diagnosed post-natally. Prenatal sonograpic findings include skin edema, hydrothorax, polyhydramnios and cardiac defects, such as pulmonic stenosis and hypertrophic cardiomyopathy but these may become apparent only in the third trimester.
Osteogenesis imperfecta type 11*	AR	1 in 60,000	Lethal skeletal dysplasia. Short limbs and ribs with multiple fractures, hypomineralization of the skull.
Perlman syndrome	AR	Rare	Similar to Beck with-Wiedemann syndrome. Fetal and neonatal mortality is more than 60% and, in survivors, there is a high incidence of neurodevelopmental delay. Sonographic features include progressive macrosomia and enlarged kidneys.
Roberts syndrome	AR	Rare	Associated with the cytogenetic finding of premature centromere separation and puffing Characterized by symmetrical limb defects of variable severity (tetraph ocomelia), facial cleft, and microcephaly and growth restriction.
Robinow syndrome	AR	Rare	Skeletal defect with short forearms, frontal bossing, hypertelorism and

Genetic syndrome	Inheritance	Birth prevalence	Prognosis and common sonographically detectable abnormalities
			vertebral anomalies.
Short-rib polydactyly syndrome	AR	Rare	Lethal skeletal dysplasia. There are four types. Type I (Saldino-Noonan) has narrow metaphyses; type II (Majewski) has facial cleft and disproportionately shortened tibiae, type III (Naumoff) has wide metaphyses with spurs; type IV (Beemer-langer) is characterized by median cleft lip, extremely short ribs and protruberant abdomen with umbilical hernia. Prenatal sonographic findings include short limbs, narrow thorax and polydactyly.
Smith-Lemili-opitz syndrome*	AR	1 in 20,000	High perinatal and infant mortality and severe mental retardation. Prenatal sonographic features include polydactyly, cardiac defects, ambiguous or female external genitalia in the male.
Spinal muscular atrophy type I*	AR	1 in 7,000	Progressive muscle weakness leading to death before two years of age because of respiratory failure. Decreased fetal movements are commonly reported and symptoms usually start at birth or up to six months of age.
Stickler syndrome	AD	1 in 10,000	Progressive myopia beginning in the first decade of life, resulting in retinal detachment and blindness, sensorineural hearing loss, marfanoid habitus with normal height, premature degenerative changes in various joints. There may be no prenatal sonographic findings but in some cases there is a facial cleft, or micrognathia.
Thalassaemia – α	AR	Common in Mediterranean and Asian populations	The alpha locus determines a polypeptide chain, the α-chain, which is present in adult hemoglobin (α2/ß2), fetal hemoglobin (α2/gamma2) and embryonic hemoglobin (α2/delta2). Normally there are four alpha gene copies. Absence of all four α-genes results in homozygous α-thalassemia, which presents with hydrops fetalis, usually in the second trimester.
Thanatophoric dysplasia*	Sporadic	1 in 10,000	Lethal skeletal dysplasia. Severe limb shortening, narrow thorax, enlarged head with prominent forehead.
Treacher Collins syndrome	AR	1 in 50,000	Normal life expectancy. Mirognathia, deformities of the ears.
Trigonocephaly 'C' syndrome	AR	1 in 15,000	About half of the affected individuals die in infancy while survivors are severely mentally handicapped with progressive

Genetic syndrome	Inheritance	Birth prevalence	Prognosis and common sonographically detectable abnormalities
			microcephaly. Trigonocephaly, short nose, prominent maxilla.
VACTER association	Sporadic, AR	1 in 6,000	Acronym for Vertebral abnormalities, Anal atresia, Cardiac defects, Tracheo-Esophageal fistula with esophageal atresia, Radial and Renal defects. Prognosis depends on the particular combination and severity of the abnormalities present. Mental function is usually normal.
Vitamin D resistant rickets	AR	Rare	None.
Zellweger syndrome*	AR	1 in 25,000	Death occurs in the first two years of life, most commonly due to chest infections and liver failure. Prenatal features include hypertelorism, brain and cardiac defects, hepatomegaly, growth restriction.

* Genetic syndromes, which are amenable to prenatal diagnosis by DNA analysis

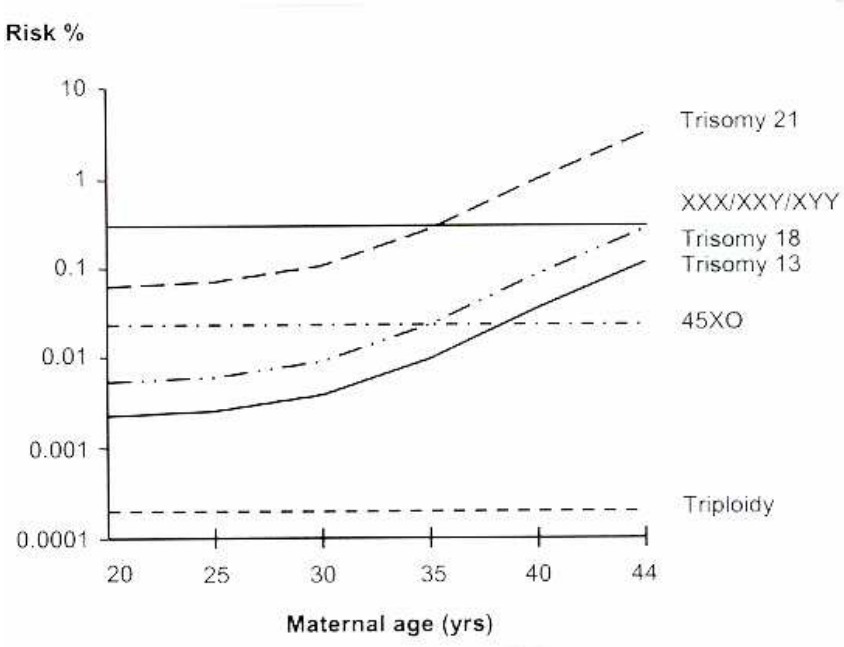
Other screening modalities for chromosomal defects:

1. Maternal age:

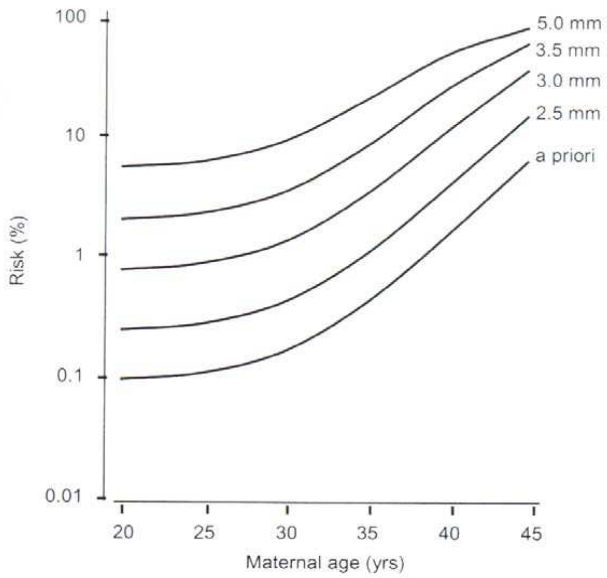
Shuttleworth in 1909 first noticed that mothers of children with Downs syndrome tended to be older than average.[57]The risk for many of the chromosomal defects increases with maternal age. Additionally, because fetuses with chromosomal defects are more likely to die in utero than normal fetuses, the risk decreases with gestational age.[58,59]

The first method of screening for Trisomy 21, introduced in the early 1970s, was based on the association with advanced maternal age. In screening by maternal age alone, about 30% of Trisomy 21 babies can be detected.[56]

Maternal age-related risk for chromosomal anomalies



Maternal age related risk for fetal trisomy 21 at 12 weeks of gestation and the effects of fetal nuchal translucency thickness



In the 1990s, screening by a combination of maternal age and fetal NT thickness at 11-14 weeks of gestation was introduced. This has shown to identify about 75% of affected fetuses with Trisomy 21.

Estimated risk for trisomies 21, 18, and 13 in relation to maternal age and gestation[60]

Maternal Age (Years)	Trisomy 21				Trisomy 18				Trisomy 13			
	Gestation (wks)				Gestation (wks)				Gestation (wks)			
	12	16	20	40	12	16	20	40	12	16	20	40
20	1068	1200	1295	1527	2484	3590	4897	18013	7826	11042	14656	42423
25	946	1062	1147	1352	2200	3179	4336	15951	6930	9778	12978	37567
30	626	703	759	895	1456	2103	2869	10554	4585	6470	8587	24856
31	543	610	658	776	1263	1825	2490	9160	3980	5615	7453	21573
32	461	518	559	659	1072	1549	2114	7775	3378	4766	6326	18311
33	383	430	464	547	891	1287	1755	6458	2806	3959	5254	15209
34	312	350	378	446	725	1047	1429	5256	2284	3222	4277	12380
35	249	280	302	356	580	837	1142	4202	1826	2576	3419	98J’6
36	196	220	238	280	456	659	899	3307	1437	2027	2691	7788
37	152	171	185	218	354	512	698	2569	1116	1575	2090	6050
38	117	131	142	167	272	393	537	1974	858	1210	1606	4650
39	89	100	108	128	208	300	409	1505	654	922	1224	3544
40	68	76	82	97	157	227	310	1139	495	698	927	2683
41	51	57	62	73	118	171	233	858	373	526	698	2020
42	38	43	46	55	89	128	175	644	280	395	524	1516

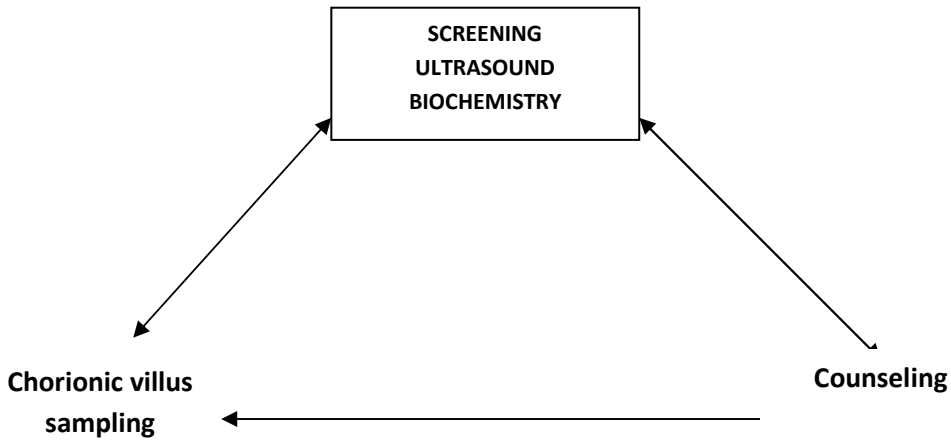
2. Maternal Serum Screening in I trimester

Today it is seen that PAPP-A (Pregnancy Associated Plasma Protein-A) is probably the best biochemical marker for detection of Downs syndrome in the first trimester.

PAPP-A is a pregnancy specific glycoprotein produced by the trophoblast and is detected in maternal serum from 28 days after conception. Low levels are associated with Downs syndrome and other trisomies. By combination of maternal age and PAPP-A, 71% of cases of Downs syndrome can be detected. By combination of Maternal age (MA)+PAPP-A+ free β HCG+ NT – 85-90% of Downs syndrome can be detected.[65-68]

OSCAR (One Stop Clinic For Assessment of Risk)[69]

Recently, maternal age was combined with fetal NT and maternal Serum biochemistry (free β HCG +PAPP-A) in the I trimester identifies about 85-90% of affected fetus. Furthermore, the development of new methods of biochemical testing, within 30 minutes of taking a blood sample, made it possible to introduce One-Stop Clinic for Assessment of risk.



3. Maternal Serum Screening in the II Trimester

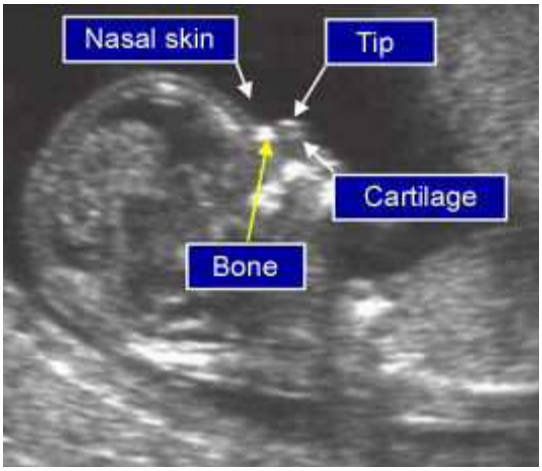
In the late 1980s, a new method of screening was introduced that takes into account not only maternal age but also the concentration of various fetoplacental products in the material circulation.[61]

At 16 weeks of gestation the median maternal serum concentration of AFP (α-fetoprotein), unconjugated estriol (UE3), human chorionic gonadotrophin (hcG) (total and free β): In Trisomy 21 pregnancies, are sufficiently different from normal to allow the use of combinations of all of these substances to select a" high risk" group.

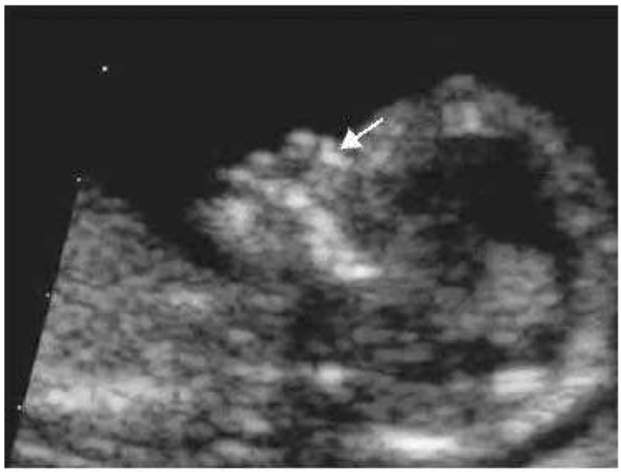
This method of screening is more effective than maternal age alone, and for the same rate of invasive testing (about 5%), it can identify about 50-70% of the fetus with trisomy 21.[62]

Biochemical Tests	**Detection Rate of Trisomy 21**
Maternal serum α-fetoprotein (MSAFP)	36%
Dual Test- MSAFP +Free β HCG	58%
Triple Test – unconjugated Estriol ↓ + β HCG ↑ + AFP ↓	67%
Quadruple test-Triple test+Inhibin A↑[63,64]	70%

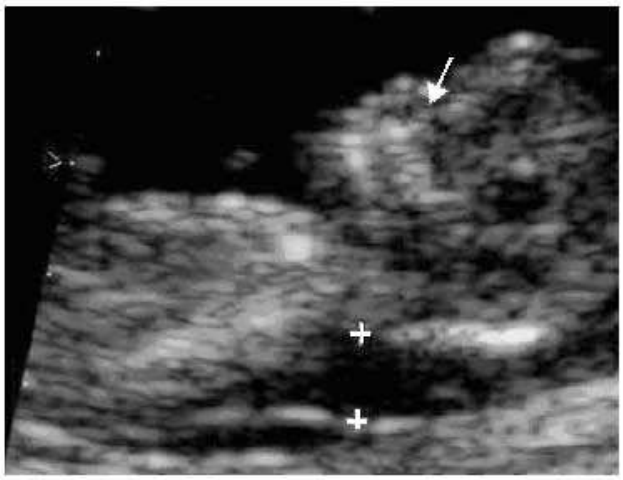
In 2001, it was found that in 60-70% of fetuses with Trisomy 21, the nasal bone is not visible by ultrasound at 11-14 weeks and preliminary result, suggest that this finding can increase the detection rate of the I trimester scan and serum Biochemistry to more than 95%[70,71]



Ultrasound picture of the fetus showing the nasal bone



Nasal bone (shown on white arrow) seen as a white line beneath the skin covering the nose.



Thickened nuchal translucency (shown within the calipers and absence of nasal bone (white arrow pointing to where the nasal bone should be)

Methods of Screening	**Detection rates (DR%)for Trisomy 21**
Maternal Age (MA)	30%
NT alone	70%
maternal serum free β HCG +PAPP-A at 11-13^{+6} weeks	70%
MA + maternal serum Biochemistry at 15-18 weeks	50-70%
MA+fetal NT at 11-13^{+6} weeks	70-80%
MA+fetal NT+ maternal serum free β hcg +PAPP-A at 11-13^{+6} weeks	85-90%
MA+fetal nasal bone(NB) + fetal NT at 11-13^{+6} weeks	90%
MA + fetal NT+ NB + maternal serum free β HCG +PAPP-A at 11-13^{+6} weeks	95%
Stepwise Sequential screen NT+1^{st} trimester serum with risk calculated , then quadruple screen with final risk including first and 2^{nd} trimester results	95%
Fully integrated screen (PAPP-A and NT in the 1^{st} +quadruple in the 2^{nd} trimester with one risk calculated.	96%
Contingent sequential screen I Trimester screen and quad test.	94%

II Trimester Ultrasonography

Benacerraf's scoring system for Down Syndrome:

Findings	Score
Major Anomaly	2
Nuchal fold > 6mm	2
Hyperechoic bowel	1
Echogenic intracardiac focus	1
Pyelectasis ≥ 4mm	1
Short femur	1
Short humerus	1

Note: A score of ≥ 2 warrants an invasive testing

Kypros H. Nicolaides

Nicolaides KH, in 1992 has been credited for being most instrumental in this field.[48] - Nuchal Translucency – "The 11-13^{+6} weeks scan."[22]

Review of studies

Recent studies have combined maternal age and NT to assess the risk of fetal anomalies.

Alexioy E et al, 2009[78] – In this study of 122 cases who underwent invasive prenatal diagnostic testing in women with increased NT revealed a positive predictive value of 14.8% for all chromosomal disorders and 9% for Trisomy 21.

Bilardo CM et al, 2007[84] – This study looked at the outcome of pregnancies with chromosomally normal fetuses and a increased nuchal translucency. A total of 675 fetuses with increased NT were studied. 33% had abnormal karyotype and 67% had a normal karyotype. The adverse pregnancy outcome was 19%.

The following table summarises the details of diagnostic accuracy of increased NT among various studies.

Study	Study Population	Gestational Age (wks)	NT cut-off	Sensitivity	Specificity	PPV	FPR
Nicolaides et al[42] (1994)	1273	10-13	≥ 3 mm	85%	95.9%	35.5%	5%
Pandya et al[72] (1995)	1763	10-13	≥ 2.5 mm	75%	92%	-	8%
Bewley et al[73] (1995)	1127	8-13 weeks	≥ 3 mm	40%	94%	-	6.1%
Taipele et al[74] (1997)	10,010	10-14 weeks	≥ 3 mm	62.3%	99.4%	24%	0.6%
Economides et al[75] (1998)	2281	11-14 weeks	≥ 99th centile	81%	99.6%	-	0.4%
Snijders et al[49] (1996)	96,127	10-14	≥ 95th centile	77%	91%	8.3%	4.4%
Hafner et al[76] (1995)	4233	10-14	>2.5 mm	65%	98.5%	14.8%	1.5%
Schwarzler et al[77] (1999)	4523	10-14	>2.5mm	76%	95.3%	8.2%	4.7%
Naidoo P et al[78] (2008)	428	11-14	>95th centile	85%	99.7%	25%	-

Materials and Methods

MATERIALS AND METHODS

A prospective study consisting of 100 antenatal women was conducted in Government RSRM lying in Hospital, Stanley medical college, Chennai, after obtaining ethical clearance from IEC, Stanley medical college.

Study period: November, 2010 to October, 2011.

Inclusion criteria

1. Antenatal women with reliable dates
2. Antenatal women with singleton viable intrauterine gestation.

Exclusion Criteria

1. Antenatal women with unreliable dates
2. Multiple gestations
3. Antenatal women who will not continue their check up until termination of pregnancy at RSRM hospital.

A detailed history of the patient was taken. Risk factors of having fetal abnormality were noted. A detailed systemic and obstetric examination was made. All preliminary investigations were done.

Antenatal women between 11-14 weeks of gestation were offered counseling before the screening. During the counseling, the patients were made aware of the benefits of ultrasound at 11-14 weeks of gestation even if not willing to participate in this study.

Women were counseled about the interpretation of the results of the screening procedure, the possibility for an invasive procedure such as

chorionic villous sampling or amniocentesis and also the risks associated with the invasive procedures.

After counseling, antenatal women were enrolled after written informed consent in the study and detailed ultrasonography was done. The scans were carried out by the trained sonologist. The following were noted namely fetal CRL, viability, Nuchal translucency, any structural abnormalities, uterine anomaly, adnexa, cervix and the internal os were noted. Then the estimated chance for having fetal abnormalities based on NT measurements were discussed with the antenatal women and her family.

These antenatal women were followed up until termination of pregnancy.

Criteria for doing invasive testing:

Women with NT >95th percentile for that gestational age and CRL, were considered to be at high risk (screen positive).

For screen positive women, fetal karyotyping was done after counseling them regarding the risk for having an anomalous fetus. Fetuses with normal karyotype were followed up with scan to detect anomalies at 18-20 weeks and fetal Echocardiography at 20-22 weeks. If lethal anomaly detected, counseling and option of termination of pregnancy was given. If no lethal anomaly was identified, pregnancy was continued till term and delivered. After delivery, the baby was evaluated for anomalies by the paediatrician and appropriate investigations were done.

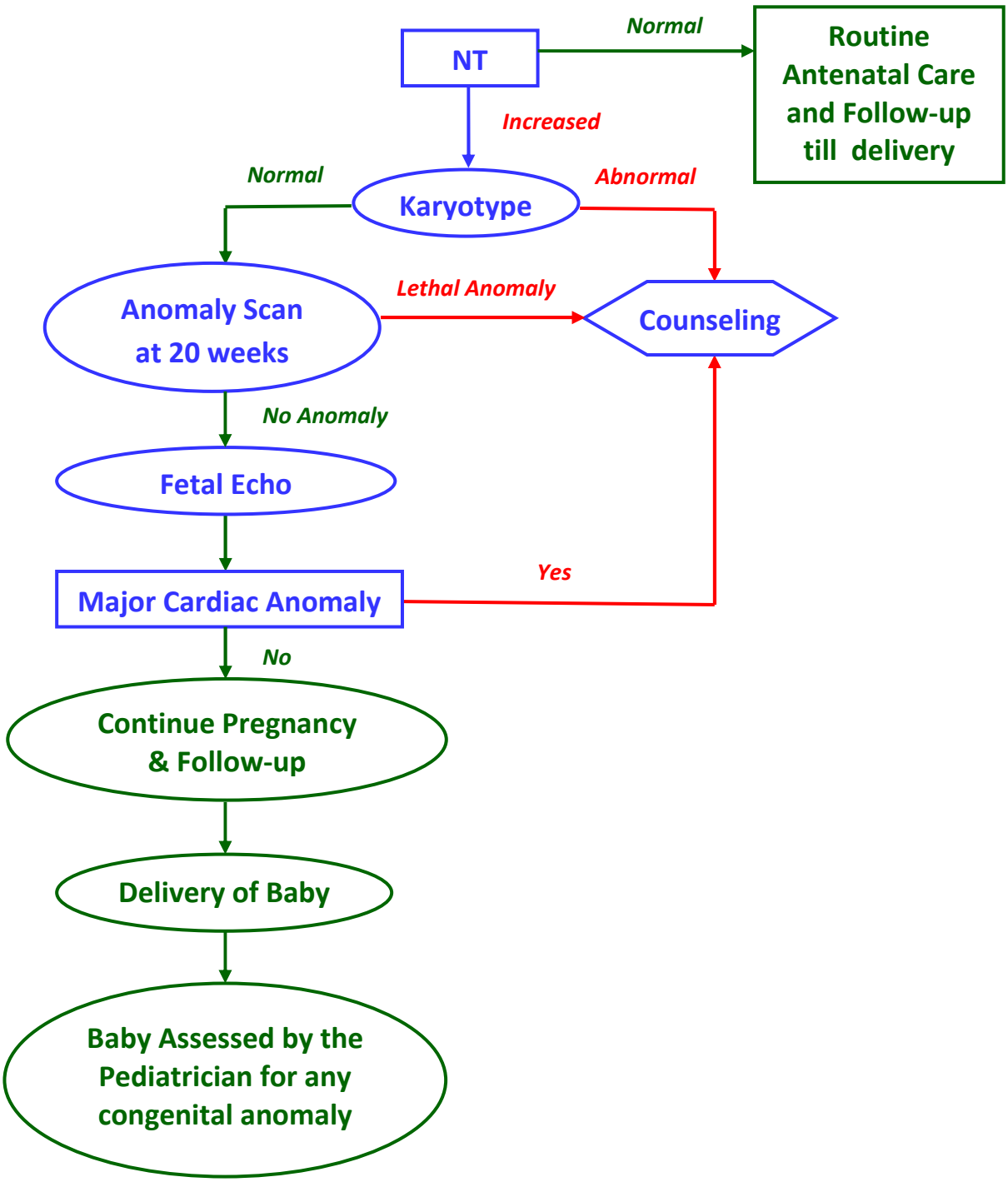
The following were used as endpoints to assess the adverse outcome of pregnancy :

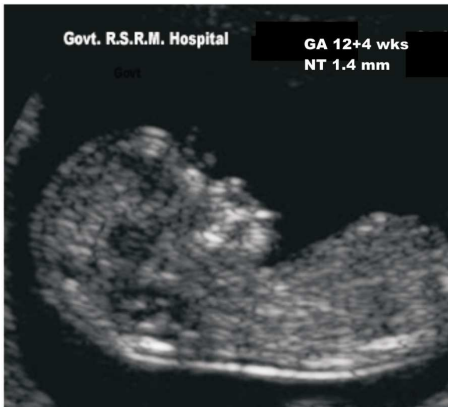
1. Pregnancy loss- spontaneous fetal loss.
2. Intrauterine death.
3. Termination of pregnancy at parental request
4. Fetal aneuploidy (Trisomy 21,13,18, Turner's syndrome).
5. Lethal congenital anomaly.
6. Postnatally identified anomalies in the neonate such as cardiac defects/ pulmonary defects/ abdominal wall defects/ skeletal defects/ genetic syndromes.

Interpretation and action

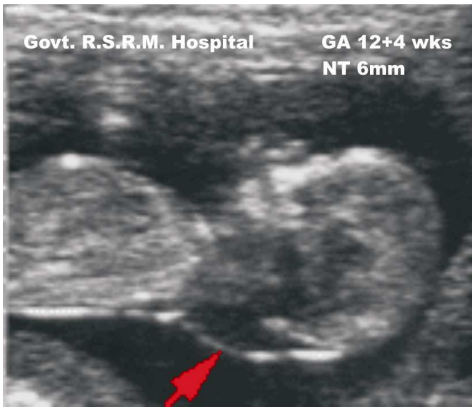
Normal NT	–	Routine antenatal care and follow up until delivery.
Increased Nuchal Translucency	-	Karyotyping (by CVS/ Amniocentesis/ Cordocentesis)
Karyotyping Abnormal	-	counseling
Karyotyping Normal	-	Continue pregnancy after anomaly scan
Lethal anomalies detected	-	counseling
No lethal anomalies	-	Fetal 2D Echo
Fetal 2D Echo (N)	-	Continue pregnancy
Lethal Cardiac anomaly	-	counseling
Following delivery	-	Evaluation by Paediatrician

ALGORITHM FOR THIS STUDY





Ultrasound picture of a fetus at 12+4 weeks gestational age, with a normal nuchal translucency (NT) [crown±rump length (CRL) 67 mm; NT 1.4 mm].



Ultrasound picture of a fetus at 12+4 weeks gestational age, with increased nuchal translucency (NT) [crown±rump length (CRL) 67 mm; NT 6 mm].

Chorionic villous sample from a woman with increased NT.

Statistical Methods

Chi-square test and student t test were used to find the statistical significance in the noted difference of anomalies associated with the fetuses with Increased NT using the statistical software namely SPSS version 15.

Sample size calculation

A sample size of 100 was arrived by using G power 3.0.10 software which determines the significance size (α) at 0.01 and power of ($1- \beta$) 0.99.

Results and Analysis

RESULTS AND ANALYSIS

Total number: 100

Table 1
Age distribution

Age in years	Number	%
≤ 20	20	20.0
21-25	41	41.0
26-30	32	32.0
31-35	3	3.0
> 35	4	4.0
Total	100	100.0

Majority (41%) of the study population were aged between 21-25 years . 7% of women were above 30 years.

Age Distribution

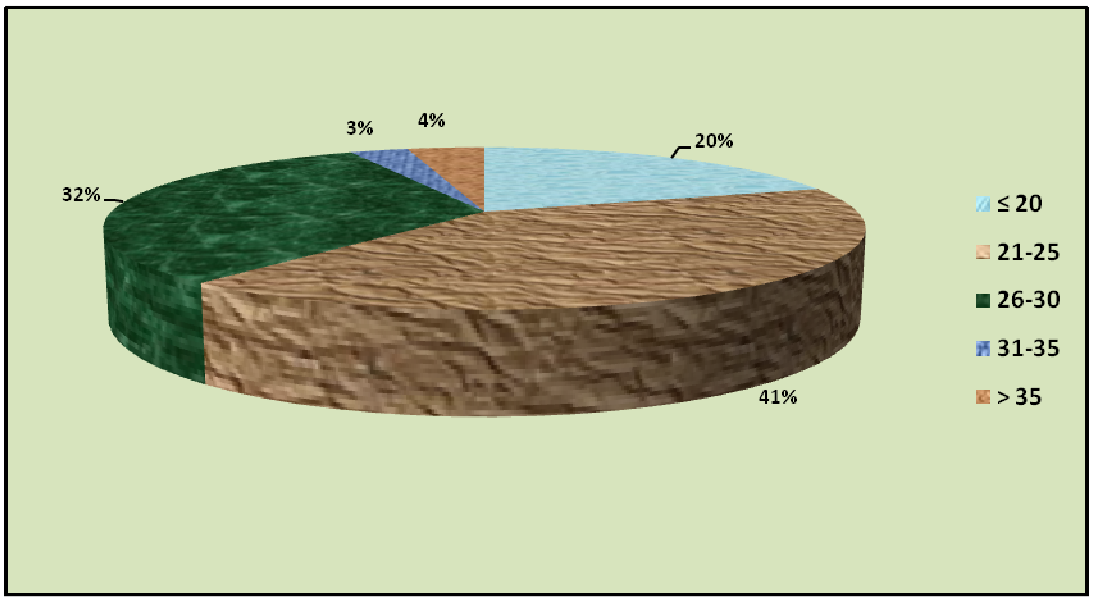


Table 2

Nuchal Translucency (NT)

Nuchal Translucency	Number (n= 100)	%
< 95th percentile	95	95.0
> 95th percentile	5	5.0

5% of our study population had increased NT

Nuchal Translucency (NT)

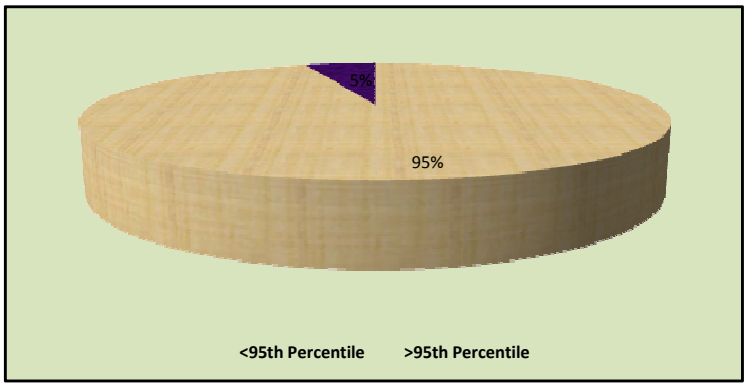


Table 3

Maternal Age in years and NT

Maternal age in yrs	Normal NT		Increased NT		Pregnancy outcome for abnormal NT
	No.	%	No.	%	
≤20	19	95%	1	5%	Turners syndrome
21-25	41	100%	0	0%	
26-30	30	93.8%	2	6.3%	1.CHD – ASD 2.CHD- VSD
31-35	2	66.7%	1	33.3%	Spontaneous fetal loss, normal karyotype, no detectable anomalies
>35	3	75%	1	25%	Downs syndrome

Mean age for women with normal NT: 24.4 years (SD- 4.3)

Mean age for women with abnormal NT: 28.8 years (SD- 6.5)

Maternal Age and NT

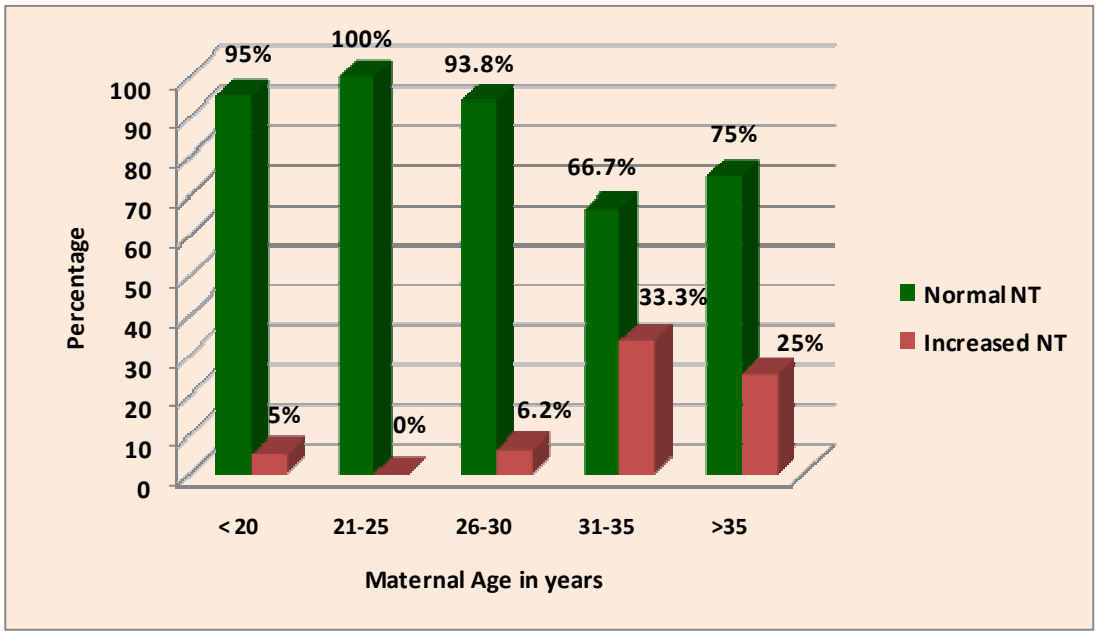


Table 4

Increased NT and its Outcome

Absolute NT Measurement (in mm)	**Pregnancy outcome for abnormal NT**
3.1	Spontaneous fetal loss, normal karyotype, no detectable anomalies
3.1	CHD – ASD
3.6	CHD- VSD
3.7	Turners syndrome
6	Downs syndrome

All fetuses with increased NT had abnormal outcome, saying that NT is an effective method of screening for fetal abnormalities

Increased NT and its Outcome

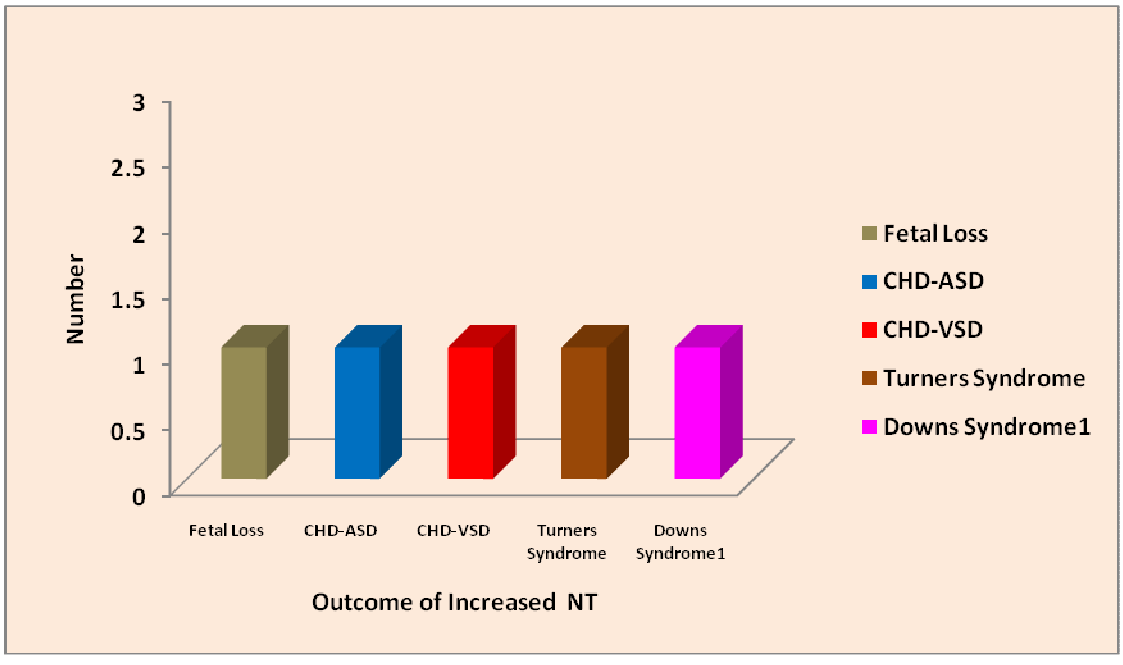


Table 5

Age vs Increased NT

Maternal age	Normal NT		Increased NT		P value
	Number	%	Number	%	
Less than 30 years	90	96.8%	3	3.2%	<0.01**
More than 30 years	5	71.4%	2	28.6%	

**- significant at 1% level

Statistically significant difference seen in the incidence of increased NT among antenatal women who were older than 30 years.

Age vs Increased NT

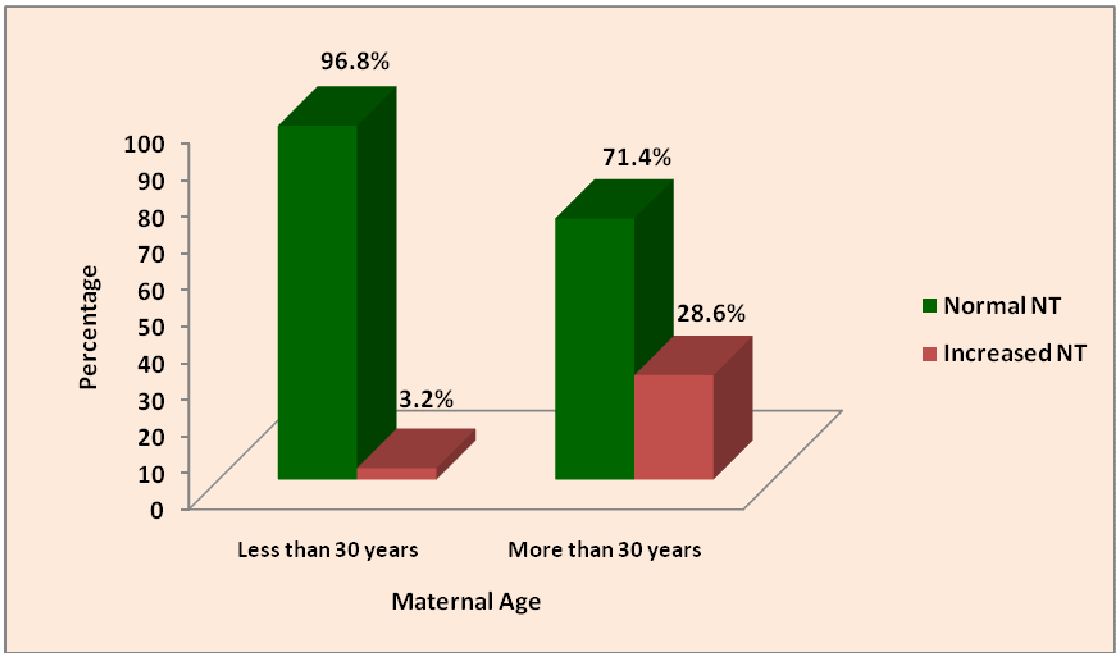


Table 6

Parity distribution

Parity	Number	Normal NT		Increased NT	
		Number	Percentage	Number	Percentage
Primi gravida	53	52	98%	1	2%
Multi gravida	47	43	91.5%	4	8.5%

Increased NT was noted more among multigravida in our study

Parity and NT

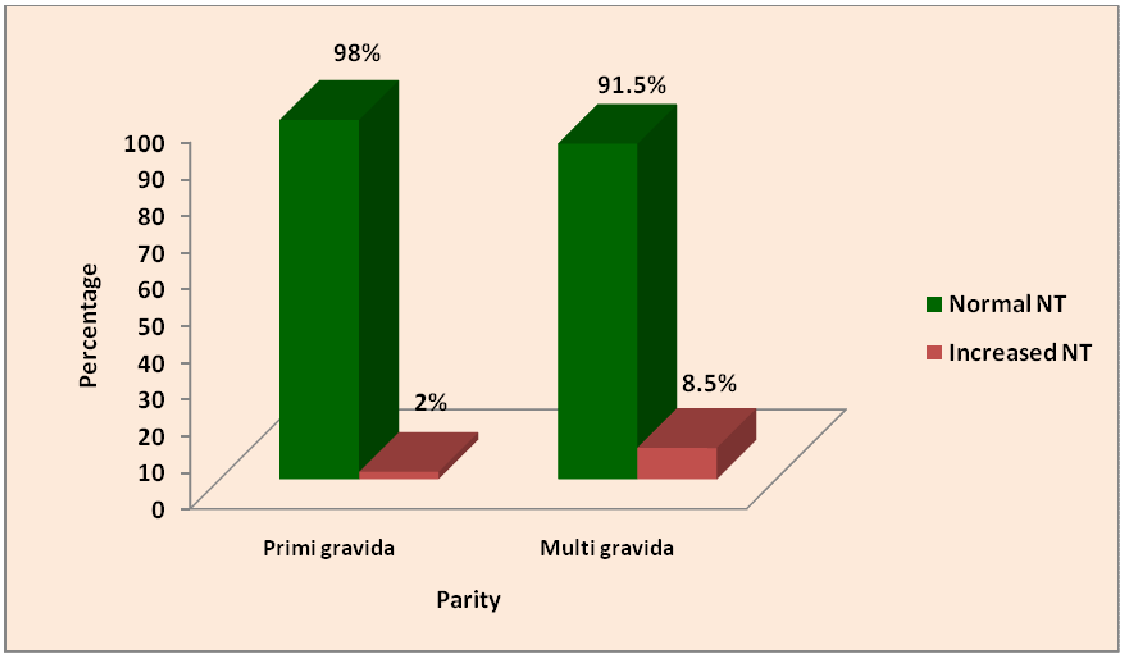


Table 7

Gestational age and NT

Gestational age In Weeks	Numbers (n=100)		Normal NT (n=95)		Increased NT (n=5)	
	Number	Percentage	Number	Percentage	Number	Percentage
11-11+6	24	24%	22	91.6%	2	8.4%
12-12+6	42	42%	40	95.2%	2	4.8%
13-13+6	34	34%	33	97%	1	3%

Majority (42%) of the women were screened between 12-12+6 weeks

Gestational age and NT

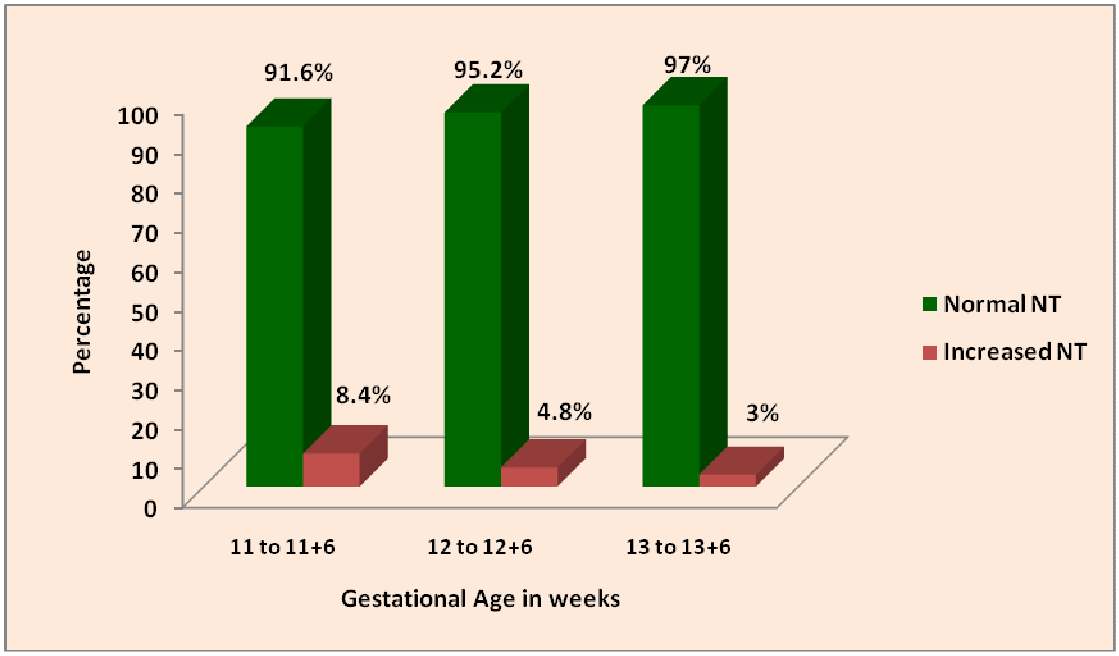


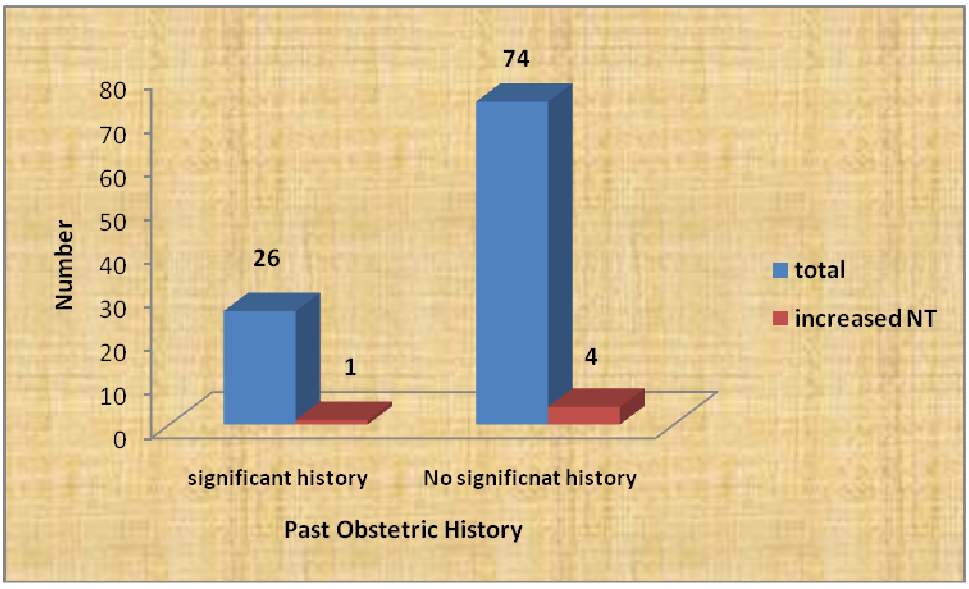
Table 8

Past obstetric history and increased NT

Past obstetric history	Number	Increased NT
History of recurrent pregnancy loss	8	1
Previous 2 LSCS	2	0
Previous LSCS	9	0
Previous antepartum eclampsia	4	0
Previous history of baby with down syndrome	1	0
Spontaneous fetal loss at 3rd month	2	0
No significant past obstetric history	74	4

Only one women with increased NT had prior obstetric history of recurrent pregnancy loss.

Past obstetric history and increased NT



Risk factors in the present pregnancy

Risk factors identified at the time of NT scan was only overt Diabetes Mellitus in 3 cases out of which 1 had increased NT.

Table 9

Obstetric problems developed beyond NT scan and its relation to abnormal NT

Risk factors in the present pregnancy	Number (n=97)	Increased NT (n=4)
1. GDM	2	0
2. Preeclampsia	9	0
3. Preterm breech	5	0
4. Postdated	14	0
5. PROM	3	0
6. No obstetric complications	64	4

4 Women who had increased NT did not have any obstetric risk factors in the present pregnancy.

Obstetric problems developed beyond NT scan

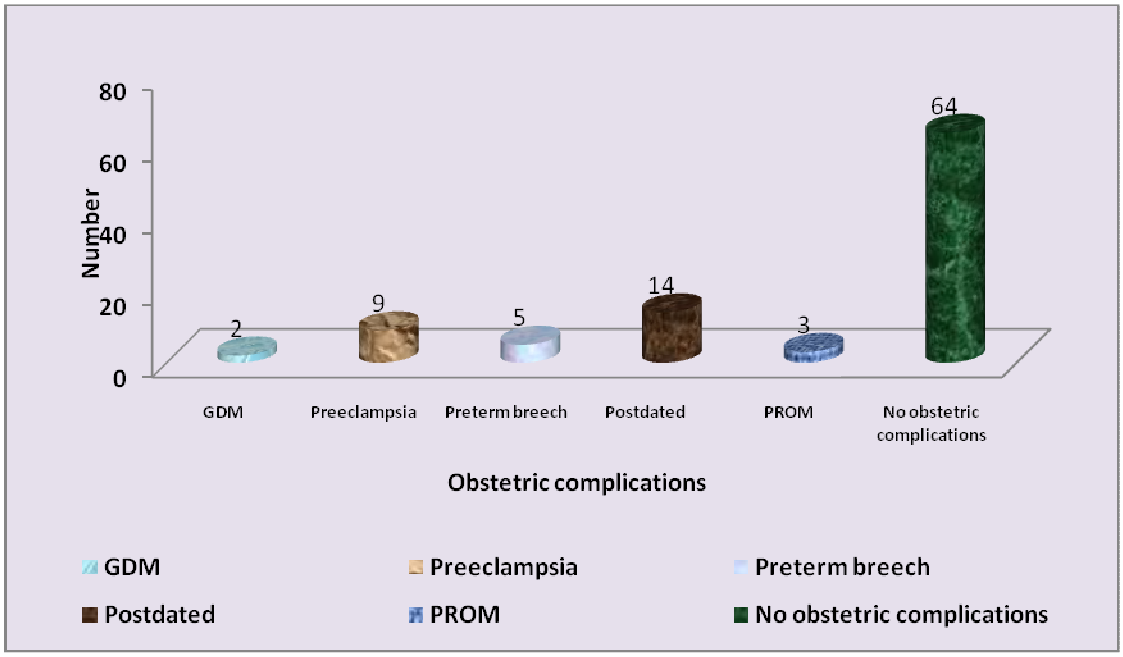


Table 10

Mode of delivery

Mode of delivery	Number (%)	Increased NT
Caesarean section	37 (37%)	1
Vaginal delivery	60 (60%)	1
Spontaneous fetal loss	1 (1%)	1
Medical termination of pregnancy	2 (2%)	2
Total	100	5

Among women with increased NT one women delivered vaginally, another women underwent LSCS, two women opted for MTP in view of fetal aneuploidies , another women had a spontaneous fetal loss

Mode of delivery

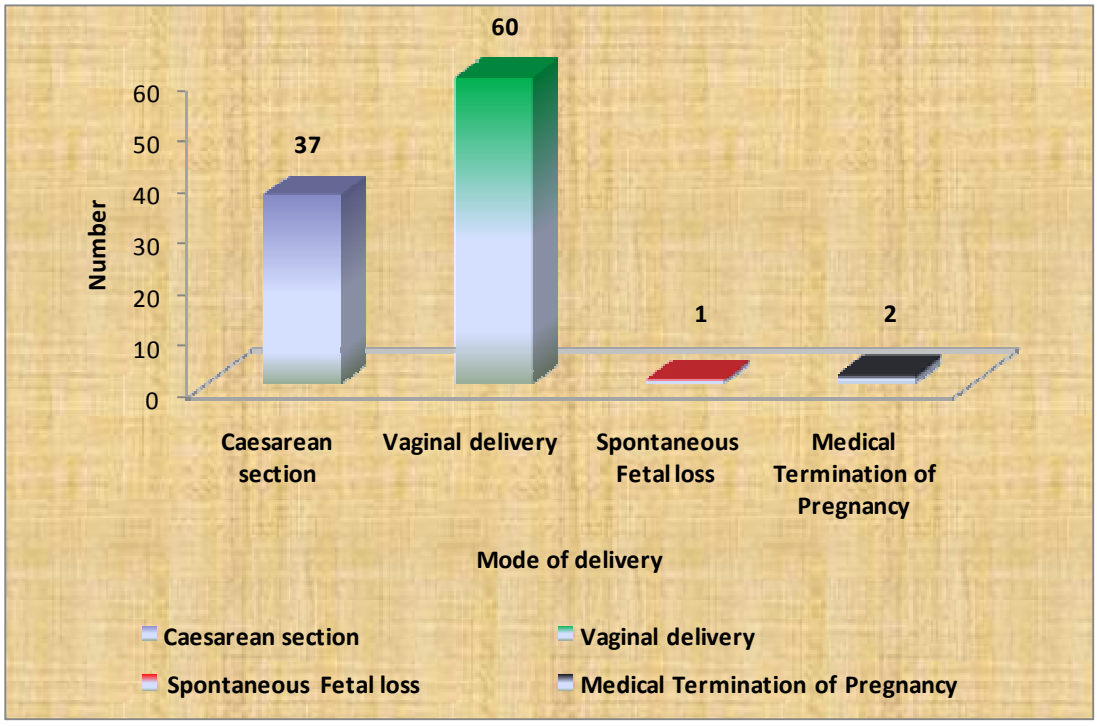


Table 11

Diagnostic value of increased NT in relation to cardiac defects

Diagnostic value of ↑ NT	Number
True Positives	2
True Negatives	95
False Negative	-
False Positive	3
Sensitivity	100.0%
Specificity	96.9%
PPV (%)	40.0%
P value	<0.001**

Statistically significant at <1%level.

Sensitivity of increased NT in identifying isolated cardiac defects is 100%.

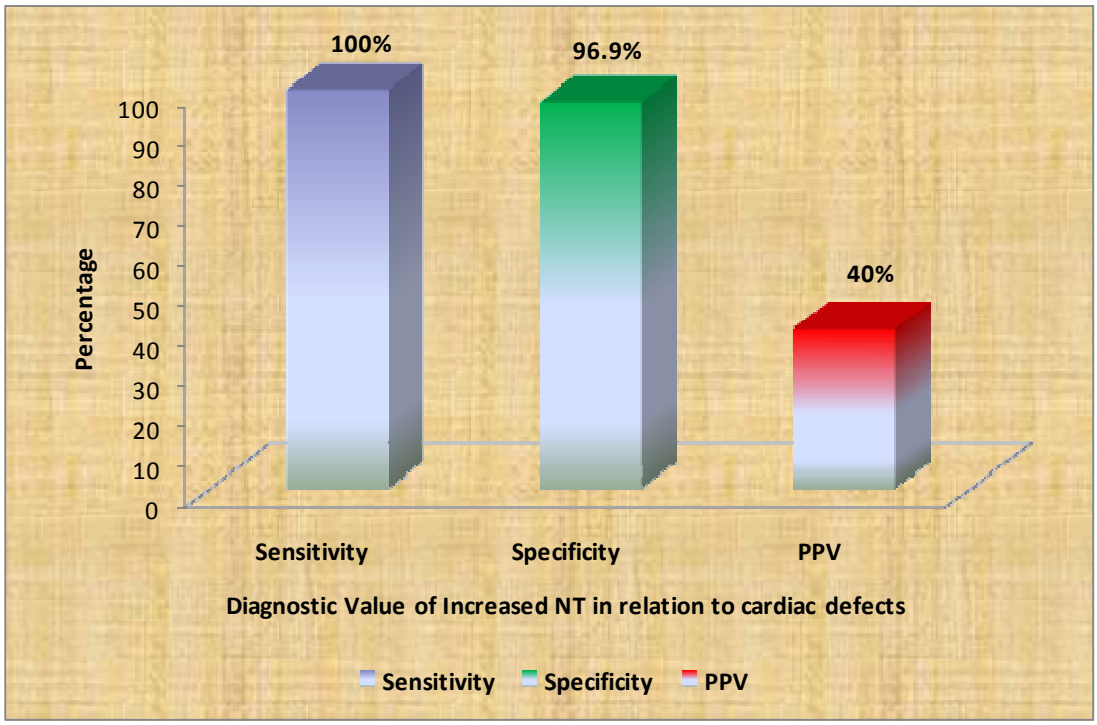


Table 12

Increased NT and Structural Anomaly in Fetus

Nuchal Translucency	No Structural Anomaly		Fetal Structural anomaly		P value
	Number	Percentage	Number	Percentage	
Normal	95	100%	0	0%	<0.001**
Increased	1	20%	4	80%	

** - significant at < 1% level

Increased NT was significantly associated with abnormal fetus. The association was statistically significant (p<0.001).

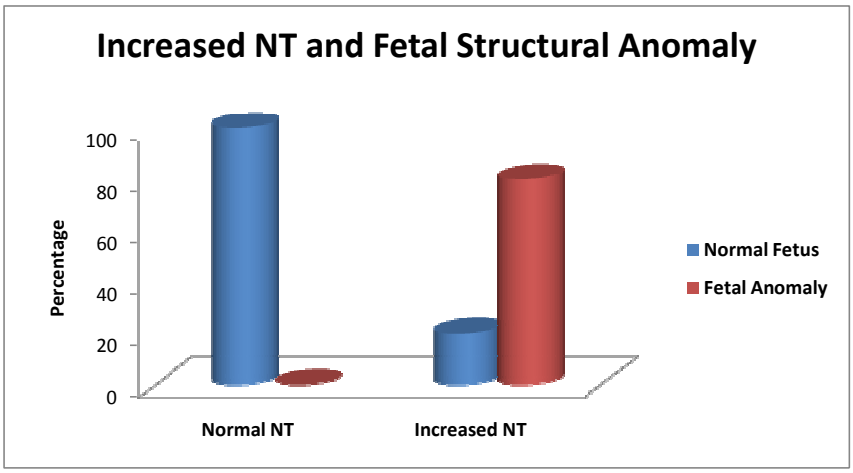


Table 13

Increased NT and Syndromic fetus

Nuchal Translucency	No Chromosomal Anomaly		Chromosomal anomaly		P value
	Number	Percentage	Number	Percentage	
Normal	95	100%	0	0%	<0.001**
Increased	3	60%	2	40%	

** - significant at < 1% level

Increased NT was significantly associated with syndromic fetus. The association was statistically significant. (P value <0.001).

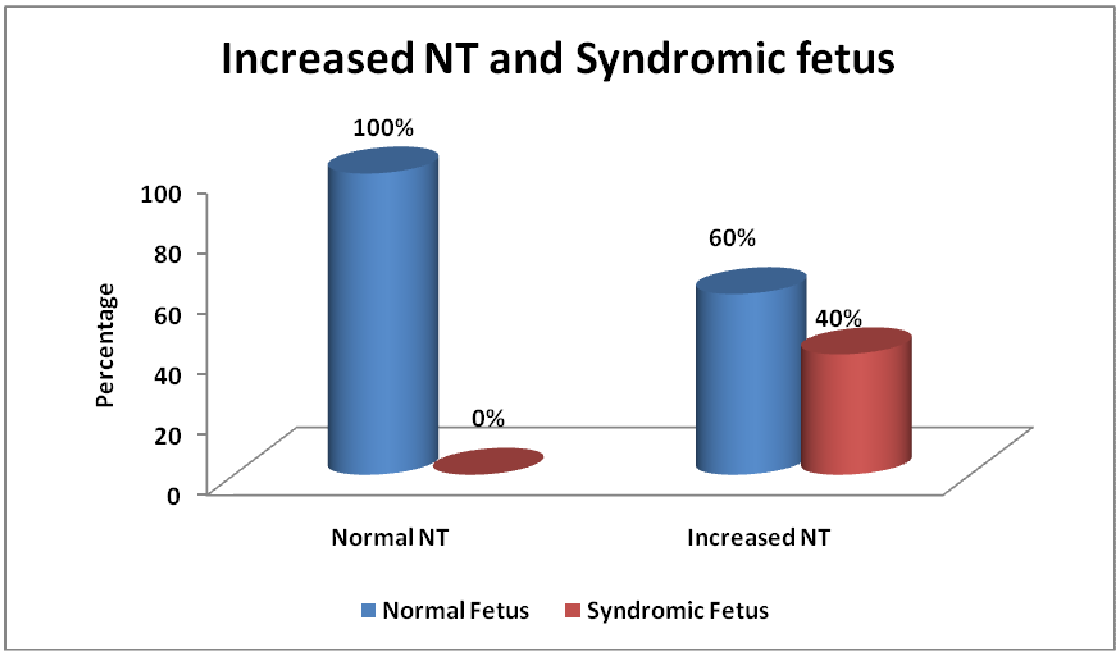


Table 14

Increased NT and abnormal karyotyping

NT > 95th percentile	Number	Abnormal karyotype	Normal karyotype
3-3.4 mm	2	0	2
3.5-4 mm	2	1	1
4.1-6 mm	1	1	0

As the value of NT increases more than the cut-off for that gestational age, the chance of the fetus having an abnormal Karyptyping is increased.

Increased NT and abnormal Karyotyping

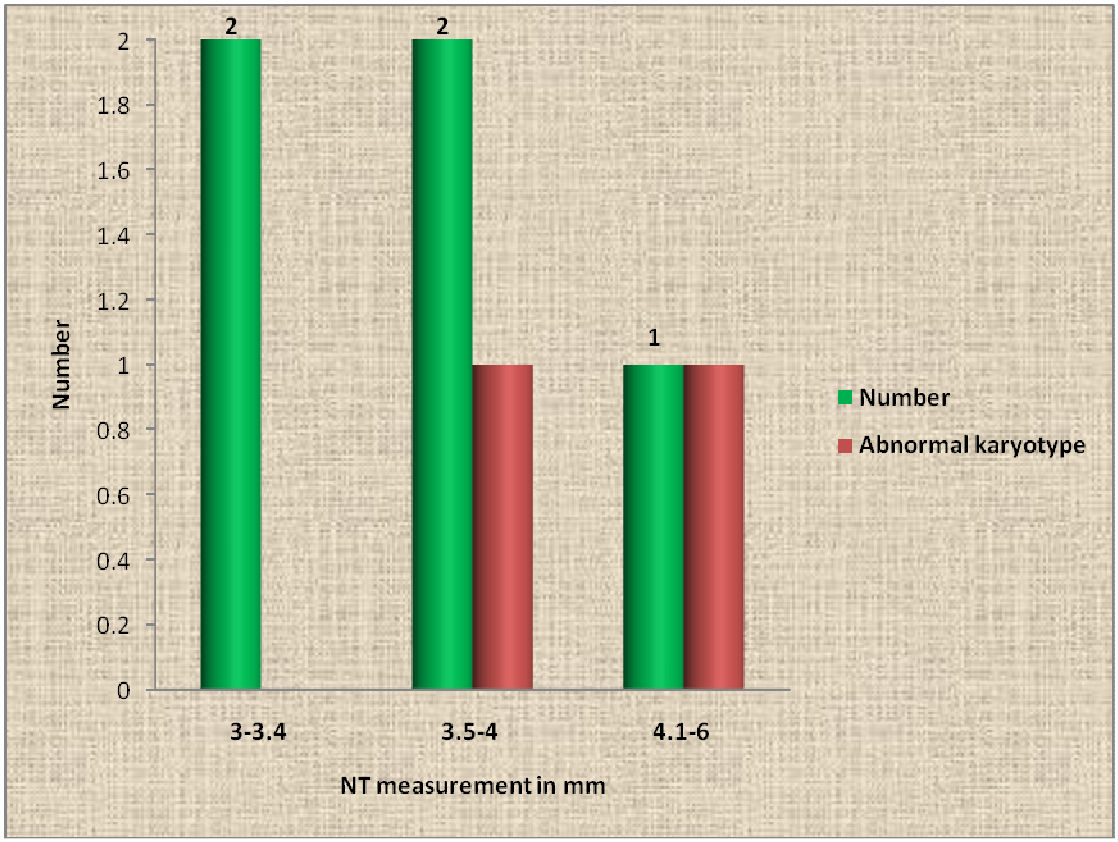


Table 15

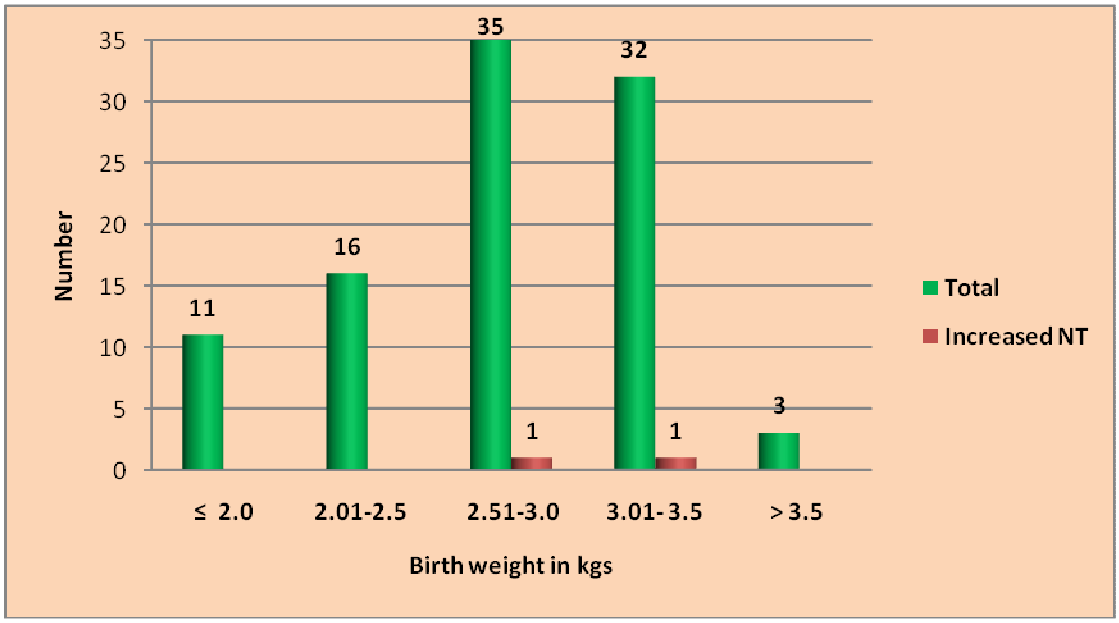
Birth weight among live births and relation with increased NT

Birth weight in kgs	Number (n=97)	Increased NT(n=2)
≤ 2.0	11	0
2.01-2.5	16	0
2.51-3.0	35	1
3.01- 3.5	32	1
> 3.5	3	0
Total	97	2

Majority of the babies had birth weight between 2.51-3.0 kgs

Two live born babies with antenatally detected increased NT were more than 2.5 kgs.

Birth weight among live birth and relation with increased NT



Discussion

DISCUSSION

One of the major goals of antenatal screening of fetal nuchal translucency at 11-14 weeks of gestation is early identification of the anomalies in the fetus.

In this study, total of 100 antenatal women were screened for fetal nuchal translucency as a marker for aneuploidies and congenital anomalies of the fetus. Majority (42%) of the women were screened between 12-12+6 weeks of gestation. Majority (41%) of the women were between 21-25 years of age. 7% of the women were above 30 years.

In our study, 95% of pregnant women had normal nuchal translucency (NT<95^{th} percentile). NT screen positivity rate (NT>95^{th} percentile) is 5% which is similar in the literature[22]. A study by Naidoo p et al[79], 2008, reported an incidence of increased NT as 15%.

The mean age for women with normal NT was 24.4 years (S.D 4.3). Mean age for women with abnormal NT was 28.8 years (SD 6.5).

Among women aged less than 30 years the incidence of increased NT is 3.2%,whereas among women above 30 years, the incidence is 28.6% .This difference is statistically significant (p value< 0.01) but this could be due to small sample size in the latter age group in our study.

With advancing age, the incidence of abnormal nuchal translucency increased in our study. This is similar to the study by Szabo

J et al[59], 1995 where increased NT was 5.4% in women >35 years and 1.3% in women < 35 years.

Fetuses with normal NT were normal at birth.

Among the 5 pregnant women with increased NT, One (20%) pregnant women had a spontaneous fetal loss at 5 months amenorrhoea. The products of conception revealed a karyotypically normal fetus by cytogenetic analysis. Souka et al[8], 2001, reported an incidence of 5.15% miscarriages among fetuses with increased NT and normal karyotyping.

All the 5 fetuses with increased NT had abnormal outcome in the form of aneuploidies (40%) (Downs syndrome and Turners syndrome), structural heart disease (40%) (VSD, ASD) and spontaneous fetal loss (20%). Both the pregnancies with fetal aneuploidy underwent medical termination of pregnancy on parental request. Study by Alexioy et al[78] reported an incidence of aneuploidies of 19% among fetuses with increased NT. Study by Bilardo et al[84] revealed 45% adverse pregnancy outcome which included aneuploidies, structural anomalies, miscarriages and termination of pregnancy on parental request.

Among the NT screen positive fetus, 60% had normal karyotyping and 40% had abnormal karyotyping (Downs syndrome and Turners syndrome).This is similar to a study done by Bilardo et al[84], Amsterdam, 2007. In the latter study which included 675 fetuses with increased NT, 67% & 33% had normal and abnormal karyotyping respectively.

Among fetuses with increased NT, four (80%) had abnormal fetuses (septal defects, aneuploidies) unlike those with normal NT among whom none had abnormal outcome. This difference noted is statistically significant (p value< 0.001). This finding makes NT measurement in first trimester as an essential screening tool.

NT measurement for detecting isolated cardiac anomaly is 100% sensitive, 97% specific but with a positive predictive value of 40%. Hence increased NT should be considered an indication for fetal Echocardiography. Study by Atzei et al,[6] 2005, reported an incidence of cardiac defects as 18% especially if the NT is more than 99th percentile.

In our study, 40% (2 out of 5) had isolated cardiac anomalies among the increased NT group. Cardiac defects were ASD and VSD.

Bilardo et al[84] study quoted an incidence of 4% isolated cardiac defects among 54 fetuses with increased NT and normal karyotype..

Among 2 live births with increased NT measurement and normal karyotyping and normal anomaly scan, both the babies had cardiac septal defects. Even these cardiac defects will not warrant a MTP even if detected in the anomaly scan. This is in contrary to the study done by Bilardo et al 2007, his study quotes adverse outcome of 4% among fetuses with increased NT, normal karyotyping and normal ultrasound at 18-22 weeks. So mere increase in NT is not an indication to terminate pregnancy.[51, 84]

In our study, distribution between primigravida were 53% and multigravida were 47%. 4 women with increased NT were multi gravida and 1 women with increased NT was a primi gravida.

36 % of pregnant women had significant risk factors in the past obstetric history (eg: previous history of fetal anomalies, previous history of Downs syndrome, prior history of recurrent pregnancy loss). Among the above, only one pregnant woman (20%) had increased NT and she was also overt diabetic on insulin.

There were no significant correlation of increased NT with present obstetric risk factors through out the pregnancy except for one pregnant woman with overt diabetes mellitus who was 37 years old and also fetal karyotyping showed downs syndrome.

Majority of the babies had birth weight between 2.51-3.0 kgs in our study.

Two live born babies with antenatally detected increased NT were more than 2.5 kgs.

Summary

SUMMARY

In this prospective clinical study, 100 pregnant women were enrolled between 11-14 weeks of gestation after informed consent, over a period of one year who attended the antenatal clinic at the department of Obstetrics and Gynaecology at Govt. RSRM hospital, Stanley medical college, Chennai.

Observations in the study includes

- Total study population is 100
- Nuchal translucency was assessed in women between 11-14 weeks. 42% were done between 12-12.6 weeks
- Incidence of increased NT > 95^{th} percentile was 5%.
- All the fetuses with increased NT had adverse pregnancy outcome.
- 2 among 5(40%) had chromosomal anomalies.
- Isolated cardiac defects were identified among 2(40%) fetuses with increased NT
- 1(20%) had spontaneous miscarriage.
- Chromosomal anomalies and cardiac defects were commoner association in women with increased NT.
- Increased NT is very sensitive and specific to detect cardiac defects.

- Incidence of increased NT is higher in women more than 30 years (28.6%) against women less than 30 years (3.1%), indicating higher risk for fetal abnormalities in the former group.
- Fetuses with increased NT are at higher risk of developing an anomalous fetus than with fetuses with normal NT and this difference is statistically significant.
- No significant association was noted with increased NT and past obstetric risk factors and the present pregnancy risk.

Conclusion

CONCLUSION OF THE STUDY

- Fetal nuchal translucency is a noninvasive, reliable, screening tool in the first trimester to predict fetal abnormalities including fetal aneuploidies.

- Routine first trimester screening for fetal nuchal translucency should be done in all pregnant women irrespective of the age.

- Increased fetal nuchal translucency is seen in 5% of our study population.

- Incidence of increased NT is higher among those women more than 30years indicating that these women at a higher risk for having anomalous fetus.

- Measurement of increased nuchal translucency provides the women with an early termination option in women with an anomalous fetus.

- Increased nuchal translucency with normal karyotyping does not warrant termination of pregnancy.

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Annexures

Proforma

FETAL NUCHAL TRANSLUCENCY BY
ULTRASOUND – A SCREENING TOOL FOR FETAL ABNORMALITIES

PROFORMA

Name :

Age :

Husband's Name :

Address :

O. P. No :

Education :

Occupation :

Monthly Income :

PRESENTING COMPLAINTS:

Menstrual history

regular cycles : Yes ☐ No ☐

Last menstrual period :

Expected date of delivery :

Marital history

Married since :

Consanguineous / Non-consanguineous :

Obstetric history : Gravida Para Live Abortion

S.No.	Year	Pregnancy event	Delivery outcome	Puerperium and Family planning	Baby outcome

History of previous unexplained fetal/neonatal death

History of congenital anomalies in the previous child

PAST HISTORY:

Any history of congenital defects in the mother

History of Diabetes mellitus / Hypertension / Tuberculosis / Epilepsy / Asthma/ Previous surgeries / Allergy to drugs

FAMILY HISTORY:

History of any congenital anomalies / mental retardation in both the families.

History of unexplained fetal / neonatal death/ recurrent pregnancy loss

GENERAL PHYSICAL EXAMINATION

Built & nourishment

Pallor / Icterus / Cyanosis / Clubbing / Lymphadenopathy / Edema

VITAL SIGNS: T: PR: RR: BP:

Breast :

Thyroid :

Spine :

HT : WT :

SYSTEMIC EXAMINATION

CVS :

RS :

CNS :

OBSTETRIC EXAMINATION

Sl. No. Date WT BP P/A

P/V

INVESTIGATIONS

A) Routine:

Hb%	HIV	BT
PCV	Hbs Ag	CT
Urine Routine	VDRL	
Blood Group and RH Typing	RBS	

B) ULTRASOUND

1. 11 - 13 weeks+6 days scan

Gestational Sac	Gestational Age
Yolk Sac	Both Adnexa
CRL	Cervix
NT	Internal OS
Anomalies	

2. If NT increased → counseling for amniocentesis / cordocentesis / chorionic villous biopsy: to determine the karyotype of fetus

If karyotype normal → II trimester scan

If karyotype abnormal + increased NT → nondirective counseling

3. II Trimester Scan:

BPD	Gestational Age
HC	FHR
AC	Interval Growth
FL	Placenta and Maturity
HL	EFW
Congenital Anomalies	EDD

If in II Trimester Scan

- No congenital anomalies detected → Continuation of pregnancy
- Lethal congenital anomalies → Counseling

4. III Trimester Scan:

BPD	Placenta
FL	FHR
HL	AFI
HC	Presentation
AC	BPP
Gestational Age	
EDD	
EFW	

Nature of delivery

Induction * Indication

* Method

Spontaneous

MODE OF DELIVERY

- Vaginal
- Abdominal

UMBILICAL CORD / PLACENTA

EVALUATION OF BABY BY PAEDIATRICIAN:

Sex

Wt

DOB

TOB

APGAR

Any congenital anomalies / cardiac defects

Perinatal mortality

Master Chart

S. No.	Name	Maternal Age	GA (Weeks)	Obstetric Code	NT (mm)		Past Obstetric history	Famiily History of Anomaly/ Mental Retardation	Risk factors in the present Pregnancy	Mode of delivery	Birth Wt.	NICU Admission	Outcome of Fetus with increased NT
1	Naomi Yesudas	22	12+1	G5A4	1.7	(N)	H/o RPL	-	-	C.S	2.5	-	
2	Nithya	26	13+6	G4P1L0A2	2.1	(N)	H/o RPL	-	-	V	2	Baby admitted for preterm	
3	Priya	23	13+1	Primi	1.3	(N)	-	-	GDM on Insulin	C.S.	3	M.A. S	
4	Ponnamma	28	13+2	G3P2L2	2.2	(N)	Prev 2 LSCS	Prev 2 babies had conganomalies	-	C.S.	3	-	
5	Geetha Devi	25	13+6	G5P3L1A1	2.1	(N)	H/o RPL	-	-	C.S.	1.8	Baby admitted for preterm	
6	Janaki	28	12+3	G4P1L1A2	1.9	(N)	Previous A.P. Eclampsia	-	Overt Diabetic	V	2.8	Baby admitted for preterm	
7	Thilagavathi	33	11+3	G2PIL1	3.1	(H)	-	-	-	--		-	Spontaneous fetal loss at 5 months girl baby
8	Allirani	35	12+6	G6P2A3L0	1.4	(N)	H/o RPL	-	Overt Diabetic	C.S.	2	Baby admitted for preterm	
9	Rathinammal	37	13+5	Primi	2	(N)	-	-	Preeclampsia	C.S.	3.25	-	
10	Razeena	21	13+3	G2P1L1	1.5	(N)	Prev. baby had downs syndrome	-	-	V	3.1	-	
11	Jayanthi	32	13+6	G6P1L1A4	1.5	(N)	H/o RPL	-		C.S.	3	-	
12	Pushpavalli	37	12+4	G2P1L1	1.9	(N)	-	-	-	V	2.9	-	
13	Kala	28	12+4	G3P2L1	1.5	(N)	Prev. 2 LSCS	Prev 2 babies had conganomalies		C.S.	3	-	
14	Sandhiya	23	13+6	G2A1	1.5	(N)	Spontaneous abortion at 3rd month			C.S.	2.8	-	

S. No.	Name	Maternal Age	GA (Weeks)	Obstetric Code	NT (mm)		Past Obstetric history	Famiily History of Anomaly/ Mental Retardation	Risk factors in the present Pregnancy	Mode of delivery	Birth Wt.	NICU Admission	Outcome of Fetus with increased NT
15	Barvin	21	12+4	G3A2	1.9	(N)	H/o RPL	-	-	V	1.1	Baby admitted for preterm	
16	Barkathunisha	29	13+5	Primi	1.5	(N)	-	-	-	C.S.	3	-	
17	Ambika	24	13+6	Primi	2	(N)	-	-	-	V	3.4	-	
18	Mariya	21	12+4	G2P1L1	1.9	(N)	-	-	Preterm breech	C.S.	1.9 kgs	Baby admitted for preterm	
19	Julia	26	13+6	G2P14	1.8	(N)	-	-	Postdated	V	3.25	-	
20	Kasthuri	30	13+6	G2P1L1	1.8	(N)	-	-	Postdated	V	3.25	-	
21	Kannagi	37	12+4	G3A2	6	(H)	H/o RPL	-	Overt D.M. on insullin	V			Medical Termination of Pregnancy (Trisomy 21)
22	Devaki	23	11+3	Primi	1.7	(N)	-	-	Preeclampsia	V	3.1	-	
23	Nanthini	19	12+6	Primi	2	(N)	-	-	Postdated	V	2.5	-	
24	Rajeswari	25	13+2	Primi	2.2	(N)	-	-	Postdated	C.S.	3	-	
25	Renuka	20	12+1	Primi	1.7	(N)	-	-	Postdated	C.S.	2.5	-	
26	Vijayalakshmi	22	12+4	Primi	1.2	(N)	-	-	-	V	3.1	-	
27	Sandhya	20	12+4	Primi	2.1	(N)	-	-	Postdated	C.S.	3	-	
28	Jayalakshmi	21	11+6	Primi	1.2	(N)	-	-	-	V	3.25		
29	Menaka	20	13+1	Primi	2	(N)	-	-	PROM	C.S.	3.75	-	

S. No.	Name	Maternal Age	GA (Weeks)	Obstetric Code	NT (mm)		Past Obstetric history	Famiily History of Anomaly/ Mental Retardation	Risk factors in the present Pregnancy	Mode of delivery	Birth Wt.	NICU Admission	Outcome of Fetus with increased NT
30	Ammulu	30	12+4	G4P3L2	1	(N)	-	-	-	V	3	-	
31	Sembaruthi	21	13+6	Primi	2.5	(N)	-	-	-	V	2.6	-	
32	Saraswathi	23	12+4	G2P1L1	1.5	(N)	-	-	Postdated	V	3	-	
33	Kanniammal	20	11	Primi	1.5	(N)	-	-	-	V	3.5	-	
34	Malar	28	11+1	Primi	1.5	(N)	-	-	-	V	3	-	
35	Ezhilarasi	22	13+5	G2P1L1	1.7	(N)	Prev.LSCS	-	-	C.S.	3.1	-	
36	Dhanalakshmi	28	12+4	Primi	2	(N)	-	-	-	V	2.9	-	
37	Fathima	23	11	G2P1L1	1.2	(N)	Prev.LSCS	-	-	C.S.	2.7	-	
38	Jayamalini	24	12	Primi	1.9	(N)	-	-	-	V	2.5	-	
39	Sindhya	23	11	Primi	1.2	(N)	-	-	Postdated	C.S.	3.2	-	
40	Dhanalakshmi	24	12	Primi	1.9	(N)	-	-	Preeclampsia	V	3	-	
41	Shyamala	22	13+3	G2P1L1	1.2	(N)	-	-	Preterm breech	C.S.	2.3	-	
42	Usha	29	11+1	Primi	1.5	(N)				V	1.7	Baby admitted for preterm	
43	Bhuvaneswari	25	12+3	Primi	2	(N)				V	2.5		
44	Deepa	27	11+1	G2P1L1	1.9	(N)				V	3.45		

S. No.	Name	Maternal Age	GA (Weeks)	Obstetric Code	NT (mm)		Past Obstetric history	Famiily History of Anomaly/ Mental Retardation	Risk factors in the present Pregnancy	Mode of delivery	Birth Wt.	NICU Admission	Outcome of Fetus with increased NT
45	Vardha	26	12+4	G2P1L1	1.4	(N)	Prev.LSCS			C.S.	3.5		
46	Anjugam	38	11+1	G2P1L1	1.9	(N)			Preeclampsia	V	2.7		
47	Ammulu	22	12+4	G2P1L1	1.2	(N)	Prev.LSCS			C.S.	2.5		
48	Ameena Beevi	19	11+3	Primi	1	(N)	-	-	-	V	2.9		
49	Meharunisha	18	12+6	primi	1.5	(N)				V	3.1		
50	Neelaveni	23	13+6	Primi	1.7	(N)			Preeclampsia	C.S.	3.25		
51	Varalakshmi	24	13+4	G2P1L1	2.5	(N)			Preterm breech	V	1.8	Baby admitted for Preterm	
52	Chitra	19	11+3	Primi	1	(N)	-	-	-	V	3.3		
53	Parvathi	26	13+1	G2P1L1	2	(N)	Prev.LSCS			C.S.	3.9		
54	Suganthi	28	12+2	Primi	2.1	(N)				V	3.5		
55	Valarmathi	29	12+2	G2P1L1	1.2	(N)	Prev.LSCS	-	GDM on Insulin	C.S.	3.25		
56	Mohana	21	11+3	G2P1L1	1	(N)				V	2.7		
57	Deepa	19	11+3	Primi	1	(N)	-	-	Post dated	V	2.6		
58	Latha	24	13+6	G2P1L1	2	(N)	Prev.LSCS		Preterm breech	C.S.	2.7		
59	Chitra	24	12+1	Primi	2.1	(N)			post dated	V	3.5		

S. No.	Name	Maternal Age	GA (Weeks)	Obstetric Code	NT (mm)		Past Obstetric history	Famiily History of Anomaly/ Mental Retardation	Risk factors in the present Pregnancy	Mode of delivery	Birth Wt.	NICU Admission	Outcome of Fetus with increased NT
60	Radha	19	11+3	G3A2	1	(N)	RPL	-	Post dated	C.S.	3.5		
61	Vasanthi	28	12+2	Primi	1.2	(N)	-	-	-	V	3.1		
62	Rakhi	20	12+4	Primi	2.1	(N)	-	-	-	V	2.5		
63	Saraswathi	19	12+6	Primi	1.5	(N)	-	-	-	V	1.75	Baby admitted for Preterm	
64	Bhavani	29	13+4	Primi	2.5	(N)	-	-	-	V	2.9		
65	Latha	26	11+3	Primi	3.1	(H)	-	-	-	C.S.	3.25		CHD - ASD
66	Geetha	19	12+6	Primi	1.5	(N)	-	-	-	V	2		
67	Lakshmi	27	13+1	Primi	2	(N)	-	-	-	V	3.25		
68	Jeeva	21	11+6	Primi	1.2	(N)	-	-	-	V	3.25		
69	Subashini	29	13+6	Primi	1.8	(N)	-	-	-	C.S.	2.85	MAS	
70	Kalaiarasi	27	12	Primi	1.9	(N)	-	-	-	V	3		
71	Jayadevi	29	12+5	Primi	1.2	(N)	-	-	Post dated	V	2.5	MAS	
72	Anitha	23	11	G2P1L1	1.2	(N)	Prev.LSCS	-	-	C.S.	2.6		
73	Radhika	28	13	G2P1L1	1.2	(N)	-	-	-	V	2.5		
74	Sakthi	21	13+5	G3P2L2	2.5	(N)	-	-	-	V	3.4		

S. No.	Name	Maternal Age	GA (Weeks)	Obstetric Code	NT (mm)		Past Obstetric history	Famiily History of Anomaly/ Mental Retardation	Risk factors in the present Pregnancy	Mode of delivery	Birth Wt.	NICU Admission	Outcome of Fetus with increased NT
75	Mamtha	26	12	G2A1	1.5	(N)	Spontaneous abortion at 3rd month	-	Preterm breech	C.S.	1.9	Baby admitted for preterm	
76	Shobha	26	13+6	G2P1L1	1.9	(N)	-	-	-	V	4		
77	Mubeena	27	12	Primi	1.9	(N)	-	-		V	2.75	MAS	
78	Premalatha	28	13	G3P2L1	1.2	(N)	AP Eclampsia	-	Preeclampsia	C.S.	1.25	Preterm	
79	Nalini	25	12	Primi	1.7	(N)	-	-	-	V	3.3		
80	Gomathi	23	12+5	G3P1L1A1	1.7	(N)	-	-	Post dated	V	2.55		
81	Hajeera	25	13+5	Primi	2.6	(N)	AP Eclampsia	-	-	C.S.	2.3		
82	Banu	19	12+6	Primi	1.5	(N)	-	-	Preeclampsia	V	2.7		
83	Punitha	21	11+6	G3P2L2	1.2	(N)	-	-	-	V	2.5		
84	Sudha	25	12	Primi	1.5	(N)	-	-	-	V	3.5		
85	Muthulakshmi	27	12	G3P1L1A1	1.9	(N)	Prev. LSCS	-	Preeclampsia	C.S	3		
86	Karpagam	20	11+4	Primi	1.5	(N)	-	-	-	V	2.5		
87	Bhavani	24	12	G2P1L0	1.9	(N)	AP Eclampsia	-	-	V	2.5		
88	Ruthmary	22	13+6	Primi	2.5	(N)	-	-	Preeclampsia	C.S.	2.5		
89	Neenashankar	28	12+5	G2P1L1	3.6	(H)	-	-	-	V	2.8		CHD - VSD

S. No.	Name	Maternal Age	GA (Weeks)	Obstetric Code	NT (mm)		Past Obstetric history	Famiily History of Anomaly/ Mental Retardation	Risk factors in the present Pregnancy	Mode of delivery	Birth Wt.	NICU Admission	Outcome of Fetus with increased NT
90	Shobana	20	11	Primi	1..5	(N)	-	-	-	V	3.25		
91	Nadiya	20	13	G2P1L1	3.7	(H)	-	-	-	V			Medical Termination of Pregnancy (Turners Syndrome)
92	Malliga	25	12+6	Primi	2.5	(N)	-	-	PROM	C.S.	2.5.		
93	Ramya	22	13+6	Primi	2.5	(N)	-	-	-	V	3.25		
94	Lakshmi	28	12	G2PL1	1.9	(N)	-	-	-	V	3		
95	Vijayalatha	30	13+6	Primi	1.8	(N)	-	-	PROM	C.S.	2.75		
96	Thenmozhi	21	11+5	G2PL1	2	(N)	-	-	-	V	3.25		
97	Yamini	20	13	Primi	1.2	(N)	-	-	-	V	3		
98	Soniya	18	11+4	Primi	1.4	(N)	-	-	Post dated	C.S.	3.5		
99	Anandhi	25	12+4	G2PL1	2.1	(N)	-	-	-	V	2.7		
100	Abirami	19	11+3	Primi	1	(N)	-	-	-	V	3.2		

Key to Master Chart

KEY TO MASTER CHART

N	Normal
G	Gravida
P	Para
L	Live
A	Abortion
C.S	Caesarean Section
V	Vaginal Delivery
H	High
MAS	Meconium Aspiration Syndrome
ASD	Atrial Septal Defect
VSD	Ventricular Septal Defect
RPL	Recurrent Pregnancy Loss
GDM	Gestational Diabetes Mellitus
NICU	Neonatal Intensive Care Unit
BW	Birth Weight
PROM	Premature rupture of membranes
LSCS	Lower Segment Caesarean Section
CHD	Congenital Heart Disease